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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

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Research, University Education, and Industry.

It has been customary in the past to reproach British manufacturers with their neglect of prosecuting research, whilst Germany and the States habitually prosecuted ambitious schemes and employed well paid experts. In certain directions research was forced upon us during the war. Now and then we have been fortunate enough to discover a Charles Darwin, who has sufficient private income to maintain him while he devotes himself to scientific discovery. Something has also been done by the research scholarships or studentships at the Universities. But the first of these depends upon the lucky chance of special ability combined with inherited wealth, while the second, useful though it is, lasts but for a short time and then leaves the research student to find a living as best he can.

Now Sir Alfred Yarrow's generous gift of £100,000 to the Royal Society opens out a new field. The Council of the Society have decided that the best way to promote research is to recognise it as a definite profession and to make it capable of providing a livelihood. They observe that there is a marked deficiency of positions in which a man who has already proved his capacity can continue to regard research as the main occupation of his life. With Sir Alfred Yarrow's endowment, the Royal Society proposes to found certain professorships, of which the holders will be expected to give their whole time to scientific research. At present a professor's first business is to teach, and his second to carry on original work in his special subject; under the Yarrow Foundation, this practice will be reversed, and the new professors will treat instruction of advanced students as their secondary function.

Just as we have neglected research, so we have tended to look down on a university education as a preliminary to a business career, although in the U.S.A. and in Germany, very different views have prevailed. Four years ago an Association for Education in Industry and Commerce was formed with the idea that the administrators of industry should be thoroughly educated. The Association has just held its fourth annual conference, where much was said about the relationship between University education and a business career. Lord Burnham, who is this year's President, when discussing the question of publicity and the usefulness of the well-educated as against the merely trained man, declared that the art of advertising deserves much more careful study than it has yet received; certainly many good ideas have been spoilt by the illiterate way of carrying them out. The late Sir H. Beerbohm Tree, who was a master in the art of attracting public notice, was one of the first to see that, if you have a pictorial advertisement, you should have your picture painted by an artist.

Some business men still think that three years at one of the older universities is not a good training for business, and it is doubtless true that a young man may go through Oxford or Cambridge without much development of his intellectual faculties. As Mr. John Knox (of Lever Brothers) told the Conference, we must somehow combine with general culture the ability to work, and it is absurdly easy to go through a University and do very little serious work. Mr. Knox is right in saying that "a curriculum which is to educate and to train managers, must at any rate train young people to work, to put forth their utmost endeavours in sustained effort, and to cultivate the power of overcoming personal *inertia*." No doubt, as the Bishop of Manchester says in his biography of that great Headmaster, Percival, of Clifton and Rugby, "there is no way of teaching boys to work for themselves, except by giving them the chance to idle; there is no way of teaching boys to use time, except by giving them the chance to waste it."

XUM

Chemical Requirement of Cast Iron.

Much of interest for foundrymen transpired at the recent meeting of the American Society for Testing Materials, when Mr. G. H. Clamer opened a discussion on the subject, "Is It Desirable to Include Chemical Requirements in Specifications for Cast Iron?" According to the "Iron Age," a fairly spirited discussion followed the presentation of the affirmative and negative side of this question, the affirmative by Robert Job, vice-president Milton Hersey Company, Limited, Montreal, Canada, and the negative by Dr. Richard Moldenke.

Chemical Specifications for Iron Castings.

Mr. Job contended that, in general, chemical specifications are necessary in conjunction with physical requirements, because our present knowledge as to physical tests is often insufficient to definitely determine their meaning in terms of actual serviceability of the castings under practical working conditions. He contended that supplementary chemical tests have by practical experience been proved necessary to secure efficient service from the castings, owing to the lack of knowledge referred to. He cited, in particular, cast-iron car wheels, the service value of which cannot be correctly regulated by physical tests. Wheels may pass all the usual physical tests and still be far from satisfactory as to quality. For example, it has been observed that when the percentage of combined carbon exceeds a certain proportion, undue brittleness is present, and the wheel is liable to fail.

Steam cylinders for locomotives were cited as another illustration of the necessity for chemical specifications. Mr. Job contended that this iron is totally different from chilled wheel metal. In the valuation of this iron, physical tests are extremely useful, but few consumers, said Mr. Job, would have the hardihood to pin their faith merely to physical tests and, as a result of practical experience, chemical composition is being held within certain limits. Iron castings used for evaporation pans and also metal for grate bars were cited by Mr. Job as being cases where chemical specifications are necessary to supplement the physical.

A Plea for the Negative.

In presenting the negative side of this discussion, Doctor Moldenke contended that the tendency of specifying the chemical analysis for iron castings, in addition to prescribing physical tests, is strongly deprecated, except for fixing maxima for specifically injurious elements. He contended that, where chemical analysis in specifications has been tried, the limits of the individual elements have had to be made so wide in order not to exclude suitable castings, no useful purpose could be served.

Doctor Moldenke referred to the Society of Automotive Engineers, which went into this subject thoroughly and found that to include all the compositions of castings coming under each separate line of work, for which special specifications were to be prepared, would mean that the limits for the several elements in cast iron would have to be made so wide that nothing of use would be attained, and the project was abandoned. Another reason was pointed to as consisting in the fact that the history of the development in foundry practice has shown that present-day compositions of castings are considerably different from those which were considered necessary some years back, and silicon was cited as a good example of this. There is no reason, however, said Doctor Moldenke, why a certain line of compositions which a foundryman finds gives him good results should not be given in the specifications issued under the head of "recommended practice," but not as an essential requirement. Where maxima for certain elements may be specified, it is known definitely that, when a given maximum percentage of an element is exceeded, failure may result, and that it is wise to apply this limit. The case of sulphur in cast-iron water-pipe was given as an example.

The speaker's conclusion was that it is unwise to add to the troubles of the foundryman by imposing upon him chemical requirements in addition to physical ones. Either one or the other should be imposed, but not both. If the consumer wants a given composition, the foundryman can furnish it, but then the consumer is responsible for the physical characteristics, but if the consumer wants the castings for his service requirements, the foundryman should be unhindered in working out the problem so long as the service requirement tests are met.

That physical requirements do not always give the consumer what he wants, and that test-bars cast separate do not represent the metal in the castings, was the contention of H. E. Diller, of "The Foundry," Cleveland. W. P. Putnam, president Detroit Testing Laboratories, Detroit, in a written discussion, stated that chemical composition is desirable for some castings, but for others it is unjust to the foundrymen, who should be permitted to produce castings to meet physical requirements.

In a written discussion, George K. Elliott, chief metallurgist Lunkenheimer Company, Cincinnati, showed that there was a great deal of virtue in what both Doctor Moldenke and Mr. Job had contributed, and he made a plea not to saddle the foundrymen with additional burdens. Broadly speaking, he thought they should be untrammelled, although there are exceptions. He pointed to the fact that new conditions are constantly arising, brought about by such agencies as the electric furnace and the air furnace, and a plea was made for dynamic tests. In a broad sense, he advocated that limits for carbon and silicon be not imposed, but that mechanical and physical specifications be required.

A forceful argument for chemical specifications for chilled iron wheels was delivered by H. J. Force, Delaware, Lackawanna and Western Railroad Company, Scranton, Pa., taking as a text the fact that experience has shown that an average of 900 cast-iron wheels have broken each year, entailing through accidents a loss to railroads and travelling public of over £2,000,000. He held that the use of chemical specifications would eliminate a large percentage of this unfortunate showing. He stated that the American Railway Association had asked recently for comprehensive chemical specifications for cast-iron wheels and that the Chilled Iron Wheel Association had also recommended such specifications. In the case of 45,000 wheels which had been made to chemical specifications in his own experience, failures had been practically nothing. In wheels which had failed, it had been found that the combined carbon ran as high as 1.25 to 1.45 per cent., in face of the fact that it is generally recognised that this should not exceed 0.75 per cent. He advocated the latter as a chemical specification for combined carbon, together with low manganese and not too high a phosphorus content, including also a high total carbon.

Dr. Moldenke agreed that certain chemical specifications were suitable for wheels, but not for general castings.

Iron Resources of India.—Mr. F. G. Percival, in a lecture at Jamshedpur, explained that, up to now, the Gorumahisani Hills have been feeding the blast furnaces of the Tata concern with their rich ores, consisting approximately of 60 to 62 per cent. of iron. The other deposits are at Sulaipat and Badampahar, of which the former is well situated. Generally, iron ores abound in large quantities in the hills of Orissa, and the State of Mayurbhanj has a big reserve. In the district of Singhbhum, the Jamda Hills have a big deposit and the ores there are very rich—richer even than the ores of Gorumahisani. Close to Jamda is Guoburu, another reserve of an excellent quality, owned by the Indian Iron & Steel Company, Limited, and near this are big deposits, which are the property of the United Steel Corporation of Asia. Adjoining these are the Joda Hills, containing high-grade ores, and ideal places for mining purposes. The Tatas, and Indian Iron and the United Steel Corporation are working close to one another in these ore regions in their respective areas, and the ore-fields are being connected with the main lines by railway. Indian ores compare favourably with Lake Superior ores and Newfoundland ores, which have the reputation of being amongst the biggest deposits in the world. The Indian ore-fields may be beaten only by the Brazilian fields, which are supposed to be the largest in the world.

The Works of Messrs. Rowland Hill & Sons, Ltd.

Light alloys are still insufficiently appreciated by engineers and foundrymen generally, and to evaluate their true importance, calculations based on strength per unit volume divided by the weight of this volume should be made. It was probably such a reasoning as this which decided Messrs. Rowland Hill & Sons, Limited, of Albion Foundry, King Street, Coventry, to discard all other engineering interests in 1912 and to devote their whole energy to the production of aluminium sand and die castings. Originally the engineering works of Mr. J. Hatton, who carried on business as an iron, brass and gunmetal founder, and a manufacturer of steam engines and pumps, they were taken over by the present concern in 1899. Almost at its inception the new company opened up an aluminium foundry, which by 1908 had become the most important factor in the business.

Technical Organisation.

Outstanding above all other features is the twin organisations for technical control and costing. The former was excellently described by Mr. Carey Hill in his Presidential Address before the Coventry Branch of the Institute of British Foundrymen in 1921, and printed in THE FOUNDRY TRADE JOURNAL, Vol. 24, page 319. The costing system is to be described in these columns in the near future.

The technical organisation divides itself into two main departments, technique and production, the connecting link being Mr. E. Carey Hill, who is Technical Director. The technique is in charge of Mr. Morgan Williams, and he is fortunate that the system he controls allows him to concentrate on new types of castings, because for every repeat order he can turn up a technical history card, which describes and illustrates the previous methods of running and gating which were successful, as well as any unsuccessful experiments that were tried. If a fresh design comes along, the system insists, except in case of great urgency, that a satisfactory sample casting be made, submitted to and approved by the customer, before the job is handed over to the production department.

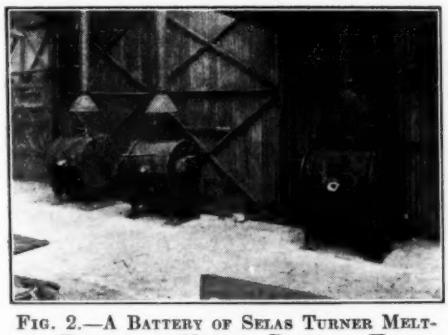

FIG. 2.—A BATTERY OF SELAS TURNER MELTING FURNACES. MESSRS. ROWLAND HILL & SONS, LIMITED.

Costing.

Whilst we do not intend to deal with this at any great length, we feel that it should be pointed out that the monthly balancing of metal stocks is really more important than the balancing of the monthly cash account. Many concerns are far too prone to insist upon knowing exactly what is done with every penny, so long as it is cash, but the moment it is translated into stocks, "as estimated by the managers," is quite sufficient. This is not so at the Albion Foundry, for by a complete clean-up once a month of all metal, both in stores or foundry, they are able to balance to a pound.

Type of Work Handled.

During the war, this firm played an important part as suppliers of highly intricate castings for aeroplanes, tanks and lorries, some of the tank castings being about 5 ft. long. Since that period it is the automobile, electrical and railway industries that have mainly been catered for. In 1917 the firm became associated with the famous French firm of M. M. De Fleury et Labruyere, or Choisy le Roi, in order that the considerable die-casting experience of the latter company should be at their disposal. This course enabled the firm to proceed straight ahead with the production of die castings, and the shop was for twelve months under the personal supervision of the French firm's experts.

Rec'd from — Patt No.
Description — Bin
Material — No. of Pieces in Patt. — No. of Core boxes — Pcs. in C-boxes

(Form 122.)

Recd.	Retd.	For Foundry Requirements.							
		Out	In	Out	In	Out	In	Out	In

FIG. 1.

Pattern Shop.

This department is replete with the usual pattern-shop tools. It is not meant, however, to be a quantity production department, but rather a quality production department, and no pains are spared to produce a pattern which will enable any time spent on its preparation to be recovered many times in the actual foundry. Normally, a contraction allowance of 1 in 96 is made for the firm's standard aluminium alloy, but this is increased when there are no cores to prevent easy contraction, as in plates or brackets.

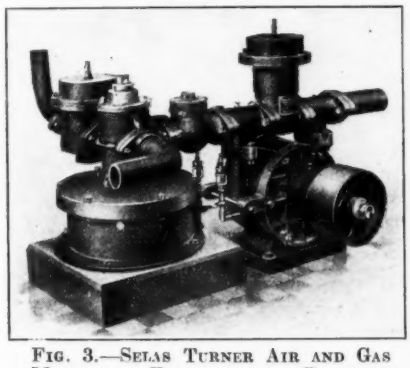

FIG. 3.—SELAS TURNER AIR AND GAS MIXER FOR USE WITH THE FURNACES SHOWN IN FIG. 2.

Pattern Stores.

There are two pattern stores, each divided up into a number of bins, the patterns from each customer being kept altogether in one bin wherever possible. The bins are numbered consecutively, and are easy of access. The booking in and out of the patterns is done on the form shown in Fig. 1.

Sand Preparation.

For aluminium castings the sand need not be very specially prepared. Messrs. Hill have found that, using Stourbridge as a base and Mansfield for facing, very little new sand is required, and this is left to the discretion of the moulder.

Melting Equipment.

Four main types of melting furnaces are used. Taking these in the order of efficiency under the conditions prevailing at the Albion Foundry, the most popular plant is a battery of three Selas Turner tilting furnaces, which are shown in Fig. 2. The furnaces are each of 300 lbs. of aluminium or 1,000 lbs. of copper capacity, and are each capable

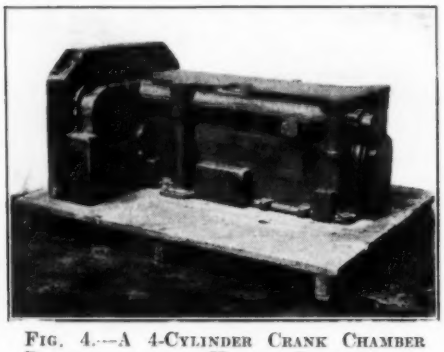

Fig. 4.—A 4-Cylinder Crank Chamber Pattern for a Heavy Commercial Vehicle or Omnibus.

of turning out eight casts per day of 9½ hours. They are fired by a mixture of town's gas and air, supplied in predetermined proportions, properly mixed by means of the special apparatus shown in Fig. 3. Secondary air is induced at the burners so as to complete the combustion of the gas, whilst still maintaining a relatively reducing atmosphere.

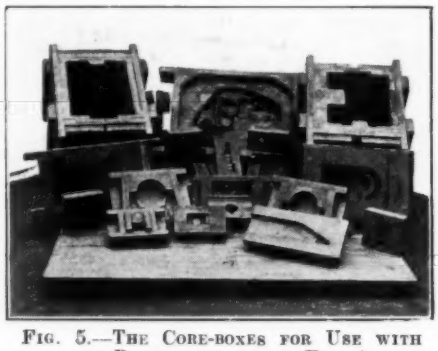

Fig. 5.—The Core-boxes for Use with the Pattern shown in Fig. 4.

Next in order of efficiency is a battery of high-pressure gas-fired crucible furnaces, which were erected by the City of Coventry Corporation Gas Department. For this purpose, town's gas is compressed to 12 lbs. per sq. in. in an electrically-driven compressor supplied by Messrs. Reavell & Company, Limited, of Ipswich. The gas is supplied to each furnace by four jets at the above

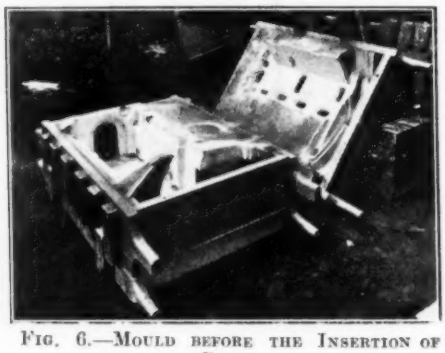

Fig. 6.—Mould before the Insertion of Cores.

pressure, sufficient air being introduced at the nozzle of the burner to ensure complete combustion. It is controlled by the distance of the gas jet from the hole in the furnace side through which the air enters. The crucibles each have a capacity of 220 lbs. of aluminium. The third type used is the well-known Morgan crucible tilting furnace, coke fired, the draught being supplied by an electrically-driven fan. The furnace incorporates an arrangement for pre-heating the charge. Finally, a large number of coke-fired pit-type furnaces are installed in convenient positions in the various foundries.

Lay-Out of Foundries.

Obviously, in an old-established works, the lay-out has had to be improvised, as additions have

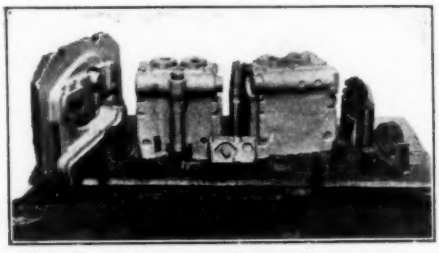

Fig. 7.—A Complete Set of Cores before Gauging.

been made from time to time. This is not such a disadvantage as one would imagine, as the character of the industry lends itself to working in small sections. Even if one were to construct a brand new foundry, to be contained under one roof, the system of making numerous small self-contained areas would still be persisted in. Thus the Albion Foundry finds but little inconvenience in operating several contiguous foundries.

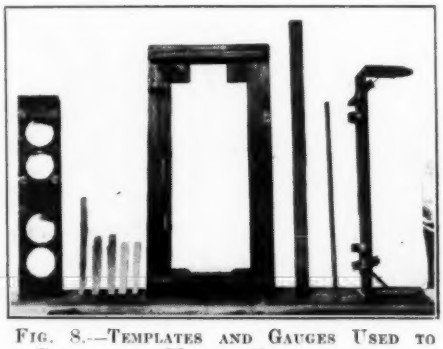

Fig. 8.—Templates and Gauges Used to Check the Mould Cores before and After Assembly and to Gauge the Dressed Casting.

Making Crank Case Castings.

A section of one foundry was, at the time of our representative's visit, being entirely devoted to the manufacture of lorry motor castings. For this purpose a gang of seven men are organised.

Two of the seven men ram up and prepare the mould, using the pattern shown in Fig. 4. A com-

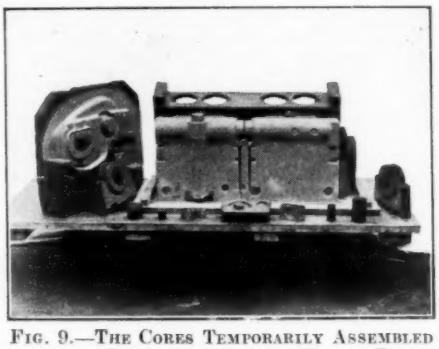

Fig. 9.—The Cores Temporarily Assembled before Insertion in the Mould Ready for Gauging with Templates.

parison between this photograph and that of the resulting casting (Fig. 12) clearly reveals the core-prints on the patterns, and, to a certain extent, the nature of the cores which fit into these prints. Fig. 5 shows all the coreboxes used in making the

necessary cores. Three men are engaged on core-making exclusively.

The mould as shown in Fig. 6 is ready to be cored up. The middle and bottom moulding boxes are *in situ*, while the top box is shown on the right-hand side, with the riser and runner holes already cut in the sand. Two men are engaged in coring up, although one of them also helps the men who ram up the pattern and prepare the mould.

Before the cores, a complete set of which is shown in Fig. 7, are inserted in the mould they are temporarily assembled together for gauging with templates. This and other gauging operations are found to be necessary on account of the very great accuracy required in the finished casting for jigging and machining purposes. Although the

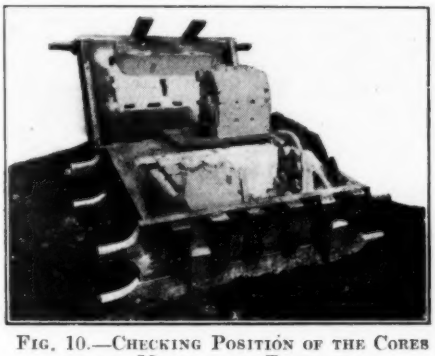

FIG. 10.—CHECKING POSITION OF THE CORES IN THE MOULD WITH TEMPLATES.

crankcase is large and heavy, it can be set up on the jigs and machined straight away, without any special manipulation on the part of the machinist being necessary. As each casting is gauged in the same way during its manufacture uniformity of dimensions in all castings is assured, likewise a cordial relationship between the foundry and the machine shop.

Fig. 8 illustrates the various gauges and templates used. Some are used to check the finished castings, and others are specially designed to check the cores and the coring up. The latter can be clearly seen in temporarily assembled cores shown in Fig. 9, and also in Fig. 11, where they

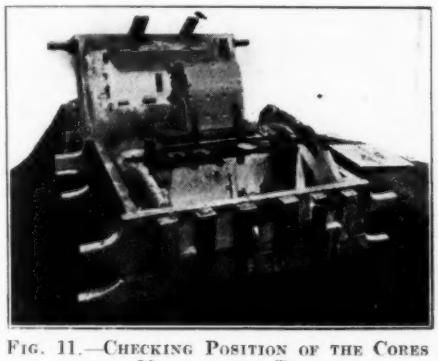

FIG. 11.—CHECKING POSITION OF THE CORES IN THE MOULD WITH TEMPLATES.

are used to check the position of the cores in the mould. Fig. 10 is identical with Fig. 11, save that no templates are shown. In each of these photographs one of the body cores is shown on the right-hand side ready for insertion. The exterior and interior of the finished castings are shown in Figs. 12 and 13.

Moulding Equipment.

Though the particular job we have described is hand-moulded, it must not be inferred that machines are not used. On the contrary, the foundry is particularly equipped with a comprehensive series of machines, including numerous hand and jar-ram machines, mainly supplied by the Britannia Foundry Company, of Coventry.

Worthy of note is a stationary Tabor roll-over shockless jar-ram machine, which is capable of taking moulds weighing 1,600 lbs. It works at an air pressure of 100 lbs. per sq. in. Another useful unit is a portable Tabor machine. Compressed air for the moulding machines is supplied by an Alley & MacLellan compressor, to which is coupled a Heenan & Froude water-cooler. It is interesting to note that the whole of the plant is so designed that the condensed moisture drains away from the machines to a suitable point near the source where it is tapped off. Fig. 4 shows the air compressor and receiver used.

Ronceray-Type Experiments.

By this sub-heading we do not imply that attempts are being made to eliminate the considerable runners and risers associated with this industry, but the making of a series of piston pots and casting them at regularly diminishing temperatures until they are too cold to cast. The

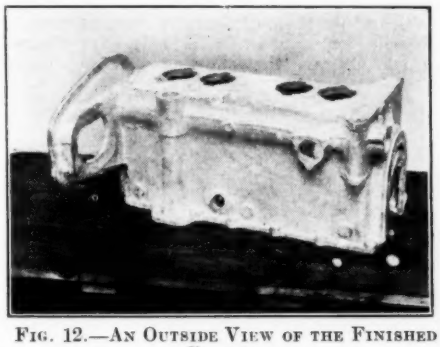

FIG. 12.—AN OUTSIDE VIEW OF THE FINISHED CASTING.

object of these experiments was to clear up the mystery of the pin holes, which are disseminated not merely on the surface, but throughout. They were conducted on several standard alloys, and the trouble was found to be mainly associated with high casting temperature. Whilst they reveal little of the real cause, the experiments gave data showing that at the lower casting temperatures, in sand, they disappeared, and even at high temperatures when die-cast do not exist.

Aluminium-Silicon Alloys.

The latest development in light alloy founding is the establishment of a 10- to 12-per-cent. silicon, silicon-aluminium alloy on a commercial basis. As

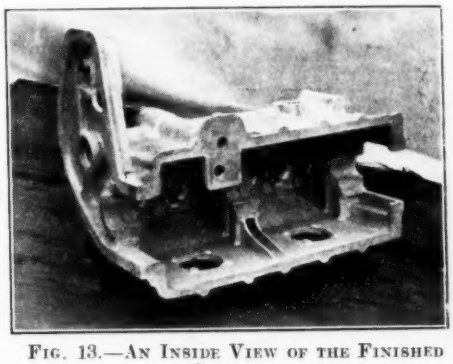

FIG. 13.—AN INSIDE VIEW OF THE FINISHED CASTING.

soon as details were available in the foundry press, Mr. Carey Hill commenced a series of interesting experiments, using metallic sodium as the "modifying agent." Using a standard commercial aluminium alloy of high repute, he cast first a gearbox, using the normal chills, and then a similar gearbox in the same alloy, but omitting the chills. The second casting weighed 3 ozs., equivalent to 0.9 per cent. less than the first casting, showing it was not as dense as the first. Further, the second casting was porous in several places, as was naturally expected.

A third gearbox was made in a modified aluminium-silicon alloy, no chills whatever being used. This casting was, as far as our representative could see, exceptionally free from any porosity or other defect, and was 1 lb. 15 ozs., or

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9.7 per cent. lighter than its counterpart in the ordinary alloy.

The second experiment concerned a funnel-shaped rear axle case, cast on its wide end, with the barrel uppermost. This barrel required abundant feeding in a standard alloy, as was clearly proved when Mr. Hill had made a casting with risers but half their normal size, for the casting was badly porous. Two castings made in aluminium-silicon alloy modified, one with risers half size and the other with no risers at all, were sound and satisfactory.

These two experiments showed that the new alloy requires neither the amount of feeding nor the quantity of denseners which normal aluminium alloys demand. This led to the casting of an aluminium-silicon alloy inlet pipe, which had been tested under water pressure for three weeks, the pressure being constant at 20 lbs. per sq. in., but quite often up to 70 lbs. The metal was only ¼ in. thick, and no trace of leakage was observed.

Tensile tests on two chill cast bars poured at 800 deg. C. gave the following average results:—

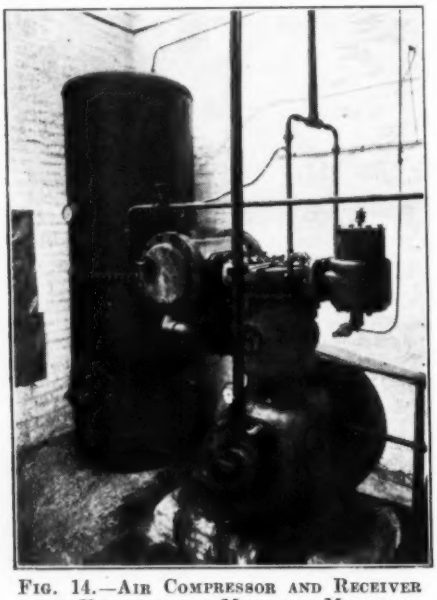

Fig. 14.—Air Compressor and Receiver for Use with the Moulding Machines. Messrs. Rowland Hill & Sons, Limited.

Max. stress, 13.45 tons per sq. in.; elongation per cent. on 2 in., 7.9 per cent.; and reduction of area per cent., 11.1 per cent.

These types of experiments are such that any foundry can carry out, and the Albion Foundry is to be commended on giving a lead which could usefully be followed by many iron foundries.

Die Castings.

Following normal custom, we do not propose to give any detailed description of the die-casting department and its associated machine shop, beyond saying that the melting arrangements are similar to those existing in the sand foundry, supplemented by gas-heated tanks in order to afford a continuous supply of metal at the proper temperature. Some of the machinery, especially a universal milling machine, the cutter spindle of which can be raised, lowered or inclined at any angle from the horizontal to the vertical, enabling all possible kinds of milling work to be done, if of a unique character.

A meeting of the Joint Conciliation Board in the South Wales Siemens Steel Trade has been held at Swansea. The subjects of consideration affected the annual agreement as to wages and conditions in the Siemens steel industry. Mr. F. W. Gilbertson presided. Two of the most important claims of the men were referred to committees, and the conference adjourned till early in August. One claim was for a week's holiday in August with wages. It was agreed to have a committee of investigation with regard to the youths' and loco. men and shunters' claims.

Competition for Brass Tap Model.

The Commercial Secretary at Buenos Aires (Mr. H. O. Chalkley, C.B.E.) reports that the Department of Sanitary Works of the Nation have issued invitations for the presentation on December 13, 1923, of models of improved brass water taps. The Department will offer three prizes of 5,000, 3,000 and 2,000 paper pesos respectively for the three best models provided they are considered sufficiently meritorious.

It is stated that the bulk of the water taps used in the Argentine are made locally and are sold at a price with which it is difficult for imported goods to compete. Certain quantities are, however, imported from Italy and from the United Kingdom. The taps used in Buenos Aires have to be of a type approved by the Department of Sanitary Works.

A translation of the conditions attached to the competition can be obtained by interested British firms on application to the Department of Overseas Trade, 35, Old Queen Street, Westminster, London, S.W.1.

Solder for Aluminium.*

Most of the metals commonly used in solders, except magnesium, are electro-positive to aluminium, so that any metals used in making a soldered joint of aluminium act electrolytically in the presence of moisture as positive galvanic poles, accelerating the corrosion of the aluminium. Magnesium cannot be utilised advantageously even though it is electro-negative to aluminium, because the metal disintegrates rapidly in the presence of moisture. Soldered joints of aluminium which are to be exposed to moisture should be protected against corrosion by a paint or varnish.

Various compositions of zinc-tin and zinc-tin-aluminium solders give the best results. The tensile strength of a good aluminium solder is about 3.1 tons per sq. in., for those with higher tensile strength have, in general, their temperature of complete liquation too high for soldering purposes. As a rule the strength of an aluminium-soldered joint depends upon the type and upon the workmanship.

Lancashire Branch Visits Bolton.

About 100 members of the Lancashire Branch of the Institute of British Foundrymen recently visited the works of Messrs. John Musgrave & Sons, Limited, of Bolton. Considerable interest was aroused in the large rolling mill castings mainly destined for India. Amongst the smaller castings, a considerable number were being made on the Ronceray principle of incorporating no feeding arrangements. The appreciation of the visitors to the directors was voiced by Mr. R. A. Miles, the Branch-President.

Paris Congress.

Two Papers are to be presented on behalf of the Institute of British Foundrymen at the International Congress in Paris. Mr. O. Smalley, of Newcastle, is to deal with some phase of the metallurgy of cast iron, and Mr. H. J. Maybury is presenting a Paper entitled "Magnesium in the Foundry." Mr. H. B. Swann, of the Cadilla Motor Car Company, is expected to present a Paper on behalf of the American Foundrymen's Association.

The shareholders of the Metallurgical Foundries, Limited, have decided to wind up the company voluntarily. Mr. E. Marston Rudland, 14, Temple Street, Birmingham, has been appointed liquidator.

Trading under the style of Aitken & Company, Messrs. H. W. Aitken, J. Shearer & W. Sommers, Britannic House, Park Circus, Glasgow, Colonial engineers, merchants and exporters, have dissolved partnership. Messrs. H. W. Aitken and J. Shearer continue the business.

* American Bureau of Mines Paper No. 78.

An Apprenticeship Course in Foundry Practice.—LII.

By Ben Shaw and James Edgar.

II.—CAST IRON.

An Impure Form of Iron.

Although cast iron is the most impure form in which iron is used commercially its usefulness covers a very wide field. It was thought at one time that the developing of steel casting would have a serious effect on the production of iron castings but, although some castings are now made in steel that were formerly made in iron, it is fairly well recognised that the demand for iron castings is more likely to increase than to diminish. This is largely due to the efforts being made to improve the quality of iron castings to suit the purposes for which they are required. There are, however, other important factors that are responsible for the increased demand for iron castings; they are relatively cheap even when the weight is increased to give greater strength, the finished castings possess a better surface and their shapes are more accurately defined than when the castings are made in steel.

Cast iron owes its value mainly to the fact that it is an impure form of iron. The other elements it contains influence its character to such an extent that it is more readily fusible, and it possesses great fluidity at a temperature much lower than steel. Just as steel is referred to as an alloy so is cast iron, but the iron content is less than in steel, whereas other elements that are contained in steel in such minor quantities that they have little influence on the metal, are present to an appreciable extent in cast iron, and their influence is considerable. Thus cast iron may be considered as an alloy of iron and carbon the percentage of the latter varying from 3 to about 3.8 per cent., but in addition it contains silicon, manganese, phosphorus and sulphur in varying proportions. It is the relative quantity of these elements and the character of their chemical composition with the iron that influences the physical qualities of the cast iron, hence, although cast iron is frequently referred to as an alloy of iron and carbon, its composition is really of a more complex character. The chemical analysis of a cast iron, while giving the relative contents in the composition does not necessarily determine the compounds formed by the elements or the condition in which the elements are present, and some form of physical test is necessary to supplement chemical analysis, in order that the quality of the cast iron for a specific purpose may be determined. In order that the composition of cast iron may be better understood it will be advisable to consider briefly the influence of its more important components.

Carbon.

Carbon is the essential element in cast iron, and the condition in which it is present is an important factor in determining the usefulness of the composition. Iron has the property of absorbing carbon. The greatest amount which it can absorb, and which is referred to as the saturation point of iron from carbon, is reached when the iron contains 4.27 per cent. of carbon, but it must be remembered that other elements which are present in cast iron may increase or decrease the solubility of carbon, and these must necessarily influence the total carbon actually combined with the iron. The carbon content of the average foundry pig is, in the main, present in an uncombined state as a mechanical admixture in the form of graphite. This graphite may be present in a flaky condition as in soft open textured pig-iron or in a powdery condition as in a tough, close-grained pig-iron. With the carbon content present wholly as graphite the softest cast iron is produced which is deficient in strength, has high fluidity and is easily machined. On the other hand, with the carbon content wholly in combination with the iron chemically, and usually referred to as combined carbon, the cast iron is exceedingly hard and brittle. Between these two extremes varying percentages of graphite and combined carbon may be present, and the hardness of the cast iron increases with the relative proportion of combined carbon present. The condition in which the carbon is present is implied by the prefix grey or white iron when alluding to the cast iron. Thus with grey iron the carbon is largely present as graphite, while with white cast iron it is almost wholly present in a combined state. This somewhat rough definition is determined by the colour of the cast iron when newly fractured. The fact that free carbon is present in cast iron can easily be determined by rubbing the finger over a newly fractured grey pig, especially if it is a very soft grey iron, for the free graphite will mark the finger, whereas the white crystalline fracture of cast iron, having carbon in a combined state, does not show any marks of a similar kind. The intermediate grade of pig-iron, in which the graphite and combined carbon are more or less balanced, is usually referred to as a mottled iron, but loosely grading the pig-iron into grey, mottled and white cast iron, according to the fracture, is not a sufficient form of classification. We shall, however, consider the subject of grading later. Combined carbon, in addition to making the iron white, hard and brittle, lowers the melting point and causes it to solidify quickly. It also increases the shrinkage during the time of solidification. On the other hand, graphite, beside making the iron grey, soft and easily machinable, raises the melting point, increases the fluidity, and causes it to solidify slowly. It reduces the amount of shrinkage during the time of solidification.

The design of a casting and the conditions under which work is cast, besides the presence of other elements or compounds, influences the character of the carbon content. Thus the rapid cooling of cast iron from a molten state tends to prevent the separation of graphitic carbon and causes it to remain in a combined state. Castings are therefore chilled at certain parts to give a very hard surface while retaining toughness and strength at other parts not treated in a similar manner. Thin castings that give off their heat rapidly, after being poured, prevent the carbon separating to a certain extent and are thus likely to be harder and more brittle than thick castings which cool more slowly and allow the graphite to separate, other things being equal.

Silicon.

Of the other elements present in cast iron silicon has the most important bearing upon the resultant constitution, and it enters more largely into the mixtures than any other. It is contained in cast iron in varying proportions up to 4.5 per cent., but pig irons of a special character can be produced with the silicon content very much higher, to which the term ferro-silicon is usually applied. These are used for introducing a definite amount of silicon to a charge that would otherwise be deficient in silicon content for the purpose it is required. The chief value of silicon is in its association with the carbon. It diminishes the power of the iron for absorbing carbon, and thus may be said to promote the formation of graphitic carbon. With a silicon content of 1.8 per cent., the cast iron is not so liable to chill as when the percentage is low and, as the percentage is increased above this point, the liability to chill is correspondingly reduced. Generally, it may be assumed, that a low-silicon iron contains more carbon in a combined state, whereas a high-silicon iron is soft and the carbon will be present almost wholly as graphite. A high-silicon iron is sometimes referred to as glazed pig from the comparatively greasy feel of its fracture. Silicon within limits increases the fluidity of the iron, because of its influence on the carbon content, and this enables the iron to free itself of blowholes and dirt better than if the contents of silicon are low and the formation of graphitic carbon is checked. Silicon opens the texture of the iron and decreases

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shrinkage. Up to about 3 per cent. of silicon the physical condition of the metal varies somewhat regularly between being extremely hard and very soft. Above this point the iron tends to become hard again. Silicon increases the tenacity of the iron up to a point, but as the amount increases and the texture becomes more open the strength diminishes. An approximate content of 1.7 per cent. of silicon gives the greatest strength, but the condition of the carbon is variable and this can only be approximate. It must not be forgotten that about 10 per cent. of the silicon is lost in passing through the cupola, and this must be considered when making up a charge.

Manganese.

Manganese assists the formation of combined carbon, tending to increase the saturation point of iron for carbon, hence, unless otherwise counteracted, its influence on the carbon tends towards the making of white iron. Within certain limits, however, manganese is valuable in cast irons, as it increases its strength and counteracts the influence of sulphur. For general work the manganese contents may be in the proportion of 0.3 to 0.4 per cent., but as much as 1.0 per cent. may be used in heavy-sectioned castings without detriment. In such cases the metal retains the fluidity for a longer time and the cooling is slower, hence the influence of the manganese for increasing the chill of the metal is rendered less effective. In other classes of castings that are not thick in section, the manganese content should be low, not more than 0.7 per cent. Within these limits it tends to toughen iron, but above 1.0 per cent., because it assists the iron to hold the carbon in chemical combination, it hardens the iron, increases shrinkage and produces a metal that is readily chilled. The manganese content is largely governed by the sulphur in the metal charged, and the quality of coke used, as it unites with sulphur to a more or less extent according to the melting conditions and is removed in the slag.

Phosphorus.

The special value of phosphorus as a component of cast iron concerns the degree of fluidity it imparts to the metal. This it increases, rendering the metal very fluid which enables dross to rise more readily. Further, it increases the time during which the metal will remain in a fluid state, and reduces the melting point. Phosphorus is present in the form of iron phosphide, which is last to solidify and forms a hard, brittle network within the crystalline structure of the metal which reduces the strength of the iron. It has the quality of assisting sulphur to combine with manganese and increasing the possibility of its removal in the slag as manganese sulphide. Within limits it is useful for quickening the metal, particularly for thin ornamental work when strength is not important. For such work made from a soft grey iron the percentage of phosphorus may be as high as 1.3, but for general engineering work the phosphorus contents should, as a rule, be below 1.0 per cent., and for castings requiring toughness and strength the contents should not exceed 0.6 or 0.7 per cent. A soft grey iron will carry more phosphorus without practical detriment than a medium or tougher grey iron. Phosphorus tends to impart cold shortness to the iron, according to the condition in which carbon is present. The greater the amount of combined carbon present the lower the percentage of phosphorus should be. Thus for chilled and malleable cast iron work or for other work in which the silicon contents are kept low, hence, having combined carbon in varying degrees, the percentage of phosphorus should be low. Castings having an excess of phosphorus are hard and brittle and are liable to fracture readily under a comparatively slight shock.

Sulphur.

The influence of sulphur upon cast iron is as a rule detrimental to its quality, and its content should consequently be kept within very low limits. Even very small percentages of sulphur influence the carbon contents and prevent it separating in the form of graphite. Sulphur thickens the iron, that is, it reduces its fluidity and an iron of low fluidity is subject to blowholes, due to gases not being able to free themselves owing to the thicker condition of the metal. Dirty metal is likely to result owing to the inability of the dross to rise from the same cause. The melting conditions influence the amount of sulphur that may be present in the fluid metal. Iron has a great affinity for sulphur, and it is absorbed by the iron from coke during the time of melting, but if the temperature of the cupola is kept up part is likely to be absorbed by the limestone flux and is carried in the slag. In this connection silicon is helpful, part of which is consumed and which raises the temperature. But manganese neutralises the effect of sulphur and is the most important element for curtailing its activities. With high manganese, a cast iron may contain a relatively higher percentage of sulphur without detriment, depending on the class of work for which it is used. Sulphur should not exceed 0.15 per cent., and for general work it is better when the contents are considerably lower, as its presence affects the influence of silicon, counteracting its softening quality to a material extent. It may be said that sulphur reverses the action of silicon and, besides reducing the fluidity of the iron, rendering it pasty and lazy, it favours the production of white iron by preventing the separation of graphite, increases the shrinkage during the period of solidification, and makes the iron hard, cold, short and relatively weak.

Grading of Cast-Iron.

When considering the various constituents of cast iron and the influence they have upon the resultant metal, it must be apparent that some form of grading is essential to obtain a suitable composition to meet the requirements of the work to be cast. Foundry irons are, therefore, generally recognised by the grading numbers, the composition of which varies, and the composition of similar numbered pig-irons, but from different blast furnaces, also varies. Usually the grey irons are in grading number from 1 to 4, No. 1 being relatively high in silicon and containing carbon almost wholly in a graphitic state. In No. 4 the silicon content is lower and a variable percentage of combined carbon is present, although the major carbon contents is in the form of graphite. Between these two other grades are made, giving a gradual change in composition. After the grey iron the grading consists of forge, mottled, and white pig. The chemical analysis of pig-irons of similar grade vary considerably, even when of the same make, and the services of a chemist are invaluable in making up a charge in order that the resultant metal will best fulfil the requirements for which it is intended. Foundry irons are usually prefixed by the name of the district in which they are made, such as Cleveland iron, Northamptonshire iron, Staffordshire iron, Scotch iron, etc., by some special form of production as in cold-blast iron, by the name of the ore used as in hematite pig-iron, or, as in special pig-irons, by the name of a special component such as ferro-silicon, ferro-manganese, etc. It is the composition of different pigs and of different brands from which a desired mixture is obtained rather than the adherence to one particular pig-iron, and the economical point of view must be considered when determining the most suitable pig-irons to stock for the work likely to be done. The character and quality of the available scrap sometimes influences the determination of the grade of pig-iron likely to be most suitable.

Cast-Iron Pipes' Long Life.—Data gathered by the Cast-Iron Pipe Publicity Bureau of Chicago, U.S.A., on the life of cast-iron pipe in municipal water distribution, reveal the fact that some pipe laid in Philadelphia in 1801 (122 years ago) is still in use. According to the Bureau's records, pipes laid in Pittsburgh in 1824, in Baltimore in 1829, and in New York in 1832, are also still in service. In the nine cities canvassed all have been using steel pipes for many years.

Swedish Ironworkers.—The Mediation Committee in the Swedish ironworkers' dispute recently put forward a proposal for a settlement to which answers were due on July 26 at the latest. According to the proposal the minimum wages of 49, 45 and 42 öre per hour are to be raised to 77, 70 and 63 (say 11d., 10d. and 9d.) respectively. No proposal, however, is submitted regarding the most important point in dispute, viz., the number of working hours, which is to be the subject of further negotiations to be concluded within a month after the resumption of work.

Manufacture of Pearlitic Grey Cast Iron in the Electric Furnace.

The present article by the late Dr. H. Frei, which appeared in the July 12th issue of "Die Giesserei," describes the synthetic production of cast iron, and especially the so-called pearlitic iron, in the electric furnace at Messrs. Brown, Boveri & Company's works in Baden (Switzerland).

The fact that the mechanical properties of cast iron depend upon its chemical composition has already been demonstrated by the systematic work of Wüst and his scholars.

This knowledge is supplemented by Kestner's work on the machining properties of metals in general and cast iron in particular. It was this worker who showed the machining qualities of a cast iron to depend upon its graphite and silicon content. This particular question as to the suitability of cast iron for machining naturally also influences the time of machining and the wages paid for the job.

As Kestner's investigations have shown, the best type of cast iron from the point of view of machining would seem to be one the structure of which is exclusively graphite and ferrite. The ideal material would therefore be a very slowly cooled cast iron containing 2.7 to 3 per cent. of silicon. But an iron of this kind does not exhibit satisfactory mechanical properties, as these are determined by the percentage of combined carbon, and it is therefore obvious that this type of cast iron would be unsatisfactory from the standpoint of sliding friction, as wear would be very considerable.

It is noteworthy that engine parts subjected to sliding friction show less wear the more closely the structure of the material approaches the pearlite-graphite, the too soft ferrite being excluded.

On the other hand, a purely pearlitic casting is obviously superior in its mechanical properties to all other kinds of cast iron.

Pearlite, in addition to being moderately hard, has a high mechanical strength. Pearlitic cast iron would be approximately as hard as a eutectic steel, were its structure not disturbed by the veins of graphite (the strength of which may be taken as = 0).

Bolton has shown that three parts by weight of graphite is equal to 12 parts by volume, so that a pearlitic cast iron containing, say, 3 per cent. graphite and 0.6 per cent. of combined carbon would be equal to a steel containing 0.6 per cent. carbon, and the strength of which was decreased by 12 per cent. of very fine hollow spaces.

Bearing in mind that with an exclusively pearlitic and graphitic structure must exhibit the greatest compactness or density to penetration by gases, which makes it extremely satisfactory for cylinders, this structure may also be regarded as the ideal.

The writer thinks that attempts were made previously to attain to the desired structure by special methods of casting. A specially suitable method is described in German Patent 325,250, Class 31c. More recently experiments have been carried out in the electric furnace with a view to producing cast iron of specially high strength and good machining qualities. The prospect of success in this direction is probably considerable, as it is easier to control the chemical composition of cast iron in the electric furnace than it is in the cupola furnace, and the expensive pig iron can be replaced by the much cheaper scrap steel.

While it is not disputed that the method of casting has considerable effect on the production of a pearlitic casting, some experiments that have been carried out by P. Honegger (head of the Foundry Department of Brown, Boveri & Company), in a Brown, Boveri design of electric furnace, show that the best guarantee for obtaining an accurate chemical composition and the attendant good qualities of the material undoubtedly lies in getting a precise chemical composition and maintaining it throughout the process.

For some considerable time now it has been possible, by working with the electric furnace and scrap material, to obtain grey cast iron having an average tensile strength of 14 to 15.2 tons per sq. in. In some cases strengths of up to and exceeding 19 tons per sq. in. have been obtained. The difficulty, however, was to get uniform strengths from one melt to another.

FIG. 1.—UNETCHED. MAGNIFIED 36 DIAS.

FIG. 2.—ETCHED WITH 5 PER CENT. SOLUTION OF NITRIC ACID. MAGNIFIED 136 DIAS.

By strict attention to the conditions of melting and casting, the above-mentioned firm have obtained a cast iron which can be machined satisfactorily. The chemical composition was carefully kept uniform for each quality of cast iron. The following figures are guaranteed: — Tensile strength, 20.32 tons per sq. in.; bending strength, 31.75 tons per sq. in.; and compressive strength, 63.5 tons per sq. in.

This material exhibits a practically pure pearlite-graphite structure.

In comparison with these guaranteed figures, the following figures have been obtained in isolated cases:—Tensile strength, 22.86 tons per sq. in.; bending strength, 34.9 tons per sq. in.; compressive strength, 71 tons per sq. in.

Some 40 to 60 tons per month of this cast iron is produced in Baden. The discard is occasionally remelted in the cupola furnace for making heavy castings. Broken machine parts are also frequently melted down again in the cupola, and the melt mixed with an equal quantity of synthetic cast iron.

An excellent raw material for the electric furnaces of this firm is provided by steel scrap, cast

iron turnings, and particularly the clippings from their dynamo sheets. The silicon content of the cast iron is accurately adjusted by adding ferro-silicon.

Bolton mentions the following conditions for obtaining pearlitic cast iron:—(1) Moderately quick cooling; (2) high casting temperature; (3) low silicon and total carbon content: (4) high manganese and sulphur content.

P. Honegger, the foundry chief at Baden, supplements Bolton's remark by stating that in a pure pearlitic cast iron with tensile strengths of 21.5 to 22.2 tons per sq. in., the total carbon content must absolutely be between 3 and 3.1 per cent. The silicon content is in the region of 1.5 per cent. and the managanese content .07 to 0.8 per cent.

As the casting temperature of the electric furnace can be considerably increased, it is easily possible to set a thin sectional casting containing 0.1 per cent. and less of phosphorus to run. In this way the disturbing effect of the phosphide eutectic is eliminated.

Bolton's fourth condition can only be taken in a relative sense. Although a high sulphur content does not impair the strength of the material, it is never desirable, because it leads to local disturbances. By using the electric furnace for pearlitic cast iron, it is not possible to get the sulphur contents which are usual in the cupola furnace (0.07 to 0.12 per cent.). Honegger states, moreover, that the sulphur content must not fall below a certain minimum if the cast iron is to exhibit the maximum of 22.86 tons per sq. in. hitherto attained.

In the present writer's investigations, the following is the approximate composition of the cast iron having a tensile strength of 22.3 tons per sq. in.:—TC, 3.08 to 3.07; Gr, 2.08; Si, 1.62 to 1.63; Mn, 0.79; P, 0.095 to 0.098; and S, 0.037 per cent., and a cast iron with the higher tensile strength of 22.7 tons per sq. in.:—C, 3.03; Si, 1.65; Mn, 2.77; P, 0.128; and S, 0.033 per cent.

The effect of lower percentages of sulphur on the tensile strength of the material is at present purely a matter of experience, and very difficult to determine on scientific grounds.

Figs. 1 to 4 show the structure of pearlitic cast iron.

The B.B.C. type of electric furnace used for the production of grey synthetic cast iron is based on the Héroult principle, and is designed for three-phase current and three movable electrodes. The furnace has a capacity of 3 to 5 tons liquid charge. The transformer for use with the furnace is designed for 600 to 700 k.v.a.

The furnace erected at Brown-Boveri's works, and fitted with basic lining, is used exclusively for synthetic grey cast iron, scrap from the works, such as iron and steel turnings, dynamo sheets, scrap iron, etc., being worked up.

The production from the furnace on an 8- to 10-hour shift is 0.75 ton per hour, with a mean furnace load of 600 kilowatts, the operations of heating, charging and pouring being included in this time. The current consumed per ton of finished castings is 800 to 900 kilowatt-hours.

The comparatively low current consumption and the uniform properties of the castings are due in no small measure to the automatic device for adjusting the electrodes with which the furnace is fitted. The B.B.C. patented electrode adjusting gear is characterised by simplicity of the various parts, the device for adjusting the electrodes being actuated hydraulically by a quick-acting valve regulator operated from a distance. This method eliminates the disadvantages of the electric motor as a regulator, with its sensitive relay, electric contacts, flexible transmission, etc.

Fig. 3.—Pearlitic Cast Iron. Etched with 5 per cent. Solution of Nitric Acid. Magnification 530 dias.

Fig. 4.—Cast Iron. Magnification 1,300 dias.

Contracts Open.

Belfast, August 22.—Stores, for the Belfast and County Down Railway Company. Mr. H. E. Mellor, secretary, Queen's Quay Terminus, Belfast.

Horncastle, July 30.—Pumping plant, for an area of about 1,200 acres in the Kirkstead drainage district, Lincolnshire. Mr. G. R. C. Harding, 29, Broadgate, Lincoln.

Kingsbridge, August 10.—Construction of a collecting tank and the providing and laying of about 1,240 yards of 3-in. cast-iron mains, etc. Mr. T. Burdett, Tacket Wood, Kingsbridge. (Fee, £1, returnable.)

London, E.C., August 14.—Carriage underframes with four-wheel bogies (66 ft. over headstocks, for the Great Indian Peninsula Railway Company. Mr. R. H. Walpole, secretary, 48, Copthall Avenue, E.C.2. (Fee, £1, non-returnable.)

London, S.E., August 10.—Carriage underframes, for the Director-General, India Store Department, Branch 14, Belvedere Road, Lambeth, S.E.1.

London, E.C., July 31.—Carriage underframes, etc., for the Great Indian Peninsula Railway Company. Mr. R. H. Walpole, secretary, 48, Copthall Avenue, E.C.2. (Fee, £1, non-returnable.)

South Australia, December 11.—Construction of 600 steel gondola cars of 40 tons capacity, 500 30-ton box cars, 100 30-ton steel louvred cars, and two wrecking cranes, all of 63-in. gauge, for the Commissioner of the South Australian Railways The Agent-General in London.

It has been decided by the Iron Trade Conciliation Board, sitting at Nottingham, that blast furnacemen and ironstone quarrymen will be entitled under the sliding scale to a 7½ per cent. rise in wages on and after the first pay-day in August.

Centrifugal Casting.*

By L. Cammen, New York City.

Centrifugal casting of metals is an old art, but did not assume commercial importance until about the time of the World War. Since then, however, its progress has been very rapid, largely because of a better understanding of the art of casting metals generally and development of materials that can be used for permanent moulds.

In the States it has powerfully affected the development of several industries. In the field of railway truck wheel manufacture the American steel foundries developed large-scale production of the Davis wheel. The Sandusky Foundry & Machine Company has for several years been successfully making bronze propeller sleeves and paper-mill rolls, and have developed the art of casting to the point where they can make large diameter tubes up to 26 ft. long.

The U.S. Cast Iron Pipe & Foundry Company has entered into the manufacture of centrifugally cast-iron pipe on a large scale, with the result that it would not be an exaggeration to say that sand-cast cast-iron pipe is doomed. Of late centrifugal casting has acquired a further importance through the development of a method by which tubes and plates can be cast in such metals as monel and alloy steel, and there are already several plants which are preparing to place on the market monel metal seamless tubing, tubing of high temperature alloys with chrome-iron base, bronze bushings and even standard steel pipe and plate.

Finally, a method has been found to apply centrifugal casting to the production of ingots from tool bits to 16-in. ingots, which promises to spread the process through the entire steel industry.

Mechanics of Centrifugal Casting.

As regards the mechanics of centrifugal casting, the choice lies between casting on a horizontal axis, on a vertical axis and on an inclined axis. When a material is cast on a horizontal axis and the axis of the object is coincident with the axis of rotation, a perfect cylinder is obtained. If the axis of the object does not coincide with the axis of rotation, a centrifugal cylinder is obtained with the walls of the casting thicker at the one side and thinner at the other side. These may prove useful in casting such objects as piston rings. In casting on a vertical axis the external surface of the casting follows, of course, the shape of the mould, while the interior is a paraboloid of revolutions.

Casting on a vertical axis may be used for short objects, in particular, such as gun shells. In casting on an inclined axis the exterior face of the object follows the shape of the mould, while the interior is a very elongated paraboloid of revolution, the shape of which depends on the angle of inclination of the machine and the speed of rotation. Such casting on an inclined axis has been employed for more than 30 years in making long tubes where the metal would not spread sufficiently fast on a horizontal axis and where it does not matter if the internal shape of the tube is not concentric with the external shape (for example, where the casting is subjected to subsequent machining). Casting on a horizontal axis is one that will particularly interest the ordinary foundryman, as the great majority of the work he may have to do will be of this character.

Temperature of Moulds.

A more important distinction deals with the temperature of the mould. In this, there are again three classes of casting which may be enumerated as castings on a warm mould, a water-cooled mould, and a hot mould. The question which mould to use depends exclusively on the size and kind of casting and the metal therein. The simplest and easiest to use, of course, is the warm mould, as it requires neither special heating nor special cooling. Warm moulds may be either permanent and made in cast iron or alloy steels, or they may be clay lined. The question is merely whether metal will properly spread in such a mould and whether it will make a good casting. This is a point which must be very clearly understood, as it lies at the foundation of all centrifugal casting work, and will, therefore, be explained in some detail.

Assuming that one has to make two steel castings—one 12 in. outside dia., 9 in. inside dia. and 36 in. long, and the other 4 in. outside dia., 3 in. inside dia. and 8 ft. long—the first casting will weigh roughly 500 lbs., and is 3 ft. long, the second will weigh 150 lbs., and is 8 ft. long. It will be clear to a practical foundryman that whereas in the first case the metal under the action of centrifugal force will spread through the short mould before it has time to chill; in the second case it is practically certain that the metal will not spread through the narrow, long mould, and that it will chill long before it reaches the end of the mould, assuming, of course, that in both cases the mould is only warm, which means, say, not in excess of 315 deg. C. It is obvious, therefore, that in the first case a warm mould may be used with comparative safety: in the second case some other arrangement would have to be made. An effort to meet this situation was made by the use of either movable spouts or trough-like arrangements in which the whole metal was poured in at once over the entire length of the mould. While certain success in cast iron has been attained with movable spout, the trough, though nearly 40 years old, has not yet been developed to a successful conclusion.

The difficulty of properly distributing the material in a warm mould led to the development of two other methods diametrically opposed in their principle, namely, the water-cooled mould (De Lavaud) and the hot mould (Cammen).

The water-cooled mould has so far been successfully used only in the manufacture of cast-iron pipe. It is obvious that metal projected against a water-cooled mould will chill instantly, and, therefore, cannot be expected to spread under the action of centrifugal force. Therefore, either the spout or the mould has to move, and, as a matter of fact, both have been attempted. In the early De Lavaud machines the spout moves, projecting a measured stream of cast iron which impinges on the walls of the mould, is flattened into a ribbon under the action of centrifugal force, and welds on to the layer just preceding it. In the later De Lavaud machine the stream of water that cools the mould is used to rotate it and move it longitudinally with respect to the spout which is stationary, so that by the time the casting is completed the mould has moved out over the spout and is ready for the extraction of the cast pipe. The process requires extreme care in the design of machinery, but with properly designed machinery is comparatively easy to operate.

One element, however, in connection with cold-mould centrifugal casting has to be very clearly borne in mind, and that is, that cast iron projected against a water-cooled mould gives a highly degraphitised metal, or a hard, brittle, white iron. This can by proper annealing be converted into grey iron of a high strength, and, in fact, tests have shown that centrifugally cast cast-iron pipe is on an average at least 20 per cent. stronger than sand cast, and claims are being made to its being even 40 per cent. stronger. The annealing of centrifugally cast cast-iron pipe has been very successfully carried out on a small scale, but what will be its cost when carried on on a large scale, say 1,000 tons a day in a single plant, is a question that only time can answer. It should be very clearly understood that no doubt is expressed as to the possibility of doing it. With modern furnaces and pyrometer control there is no question that it can be done—at a price, but what the price will be, and in particular what the waste in overheated and underheated castings, is a matter that only time can show. From our general knowledge

* Paper presented to the Cleveland meeting of the American Foundrymen's Association.

of operations of this character it would appear that unless methods of annealing are radically different than those of to-day, the waste of castings would be of an order of 15 per cent., which might go a long way towards offsetting the economic advantages of the new process.

The third process is that of hot-mould centrifugal casting, the interest of which lies in the fact that it permits of producing thin sections, say 3-16 in. and up, in considerable lengths and in comparatively small diameters. To understand this process it should be remembered that if a liquid, such as oil or mercury, be poured at one end into a rapidly rotating horizontal tube or mould, it will spread from end to end under the influence of centrifugal force and form a uniform tube. In casting metals the question of time arises, however. A molten metal will spread in exactly the same way as oil or mercury, providing it stays liquid sufficiently long, and the trouble with the majority of metals is that they are poured at temperatures only a little above their melting point, and, therefore, chill with extreme rapidity. To obviate this, the mould may be heated to a high temperature, which, in this case, means, say, 925 deg. C. for steel or monel metal, 815 deg. for brass, 650 deg. for aluminium, and so on, up and down the line. When steel is poured against a mould having a temperature of 925 to 980 deg. it does not cool instantly, as it would on coming in contact with the cold mould. In fact, it has been found that a 3-16-in. wall takes about 45 seconds to harden completely, which is sufficient to produce clean metal. It has been found that actually tubes 3½ in. outside diameter, ¼-in. wall and 6 ft. long can be produced in hot moulds without any difficulty.

There have been numberless attempts to produce by centrifugal casting discontinuous surfaces such as ingots, in particular small ingots, for example, tool bits, plate and gears with the teeth cast in. Single gears, both spur and worm gears, have been successfully produced in moulds rotating on a vertical axis, the metal being poured at what would correspond to the hub of a wheel, and it may be stated in this connection that in order to make a successful gear casting it is necessary to pour a very heavy hub, which acts as a feeder to the rest and has to be removed later on. All attempts to cast such articles on a horizontal axis have, however, failed until lately. Gears and ingots have been actually produced centrifugally by cutting what corresponds to teeth in the mould, but the metal in such castings was very poor, and in particular full of "cold shot." The reason for this is rather easy to see. When molten metal coming from the spout strikes the projections in the mould, it is started in a fan spray, which instantly chills in the air and is later on incorporated as cold shot into the casting. This difficulty has been overcome, however, recently by the use of a "bottle-neck" mould which has been described in the technical Press.

Patent Situation.

The designer of machinery for centrifugal casting should make himself fully acquainted in the patent situation. As stated above, the art of centrifugal casting is old, and the majority of the basic features in the design of machinery and in the processes themselves are now free to everybody from a patent point of view. In fact, the shanks machined for making cast-iron pipe centrifugally, described in the "Scientific American" of December 1, 1849, do not essentially differ in any way from the great majority of machines working with the cold mould at the present day. At the same time, however, there are a number of patents on minor improvements which are still valid, and any designer not familiar with what is and is not valid may either infringe on the right of someone else or let himself be bluffed by unfounded claims.

The feature of temperature control of the mould is, however, new, and both the water-cooled mould and the hot mould are covered by patents which are from all indications valid and of sufficiently recent date to be fully alive.

Field for Centrifugal Castings.

The field of centrifugal casting that may be of interest to the foundryman is very large, though, of course, materially affected by the foundry equipment already available and the location of the foundry. Practically any cylindrical body can be made by centrifugal casting in cast iron, steel or non-ferrous materials. Where the work of a foundry is seasonal it may pay to have one or more centrifugal casting machines installed and make pipe in slack times. The cost of casting machine is comparatively small, and there is always a market for either cast iron or steel pipe, especially in sections at some distance from the big sources of supply of these materials. Steel rings may also be easily cast by this process.

It should be remembered also, however, that while the principle of centrifugal casting is extremely simple, good results can be obtained only when everything is just right. It should be remembered clearly that all claims as to centrifugal force, "fluid pressure" and so on, producing better metal, are based on a misunderstanding of the process. The pressure due to centrifugal force produced by the rotation of the mould is far too low to affect the composition of the metal, and it is the rate of cooling rather than the whirling of the metal that produces the remarkable result obtained by centrifugal casting. By centrifugal casting, metal far superior to anything in sand casting can be produced, but to get such results it is necessary in the first place that the metal as it comes from the ladle should be right. There is an impression that slag, scum or dirt can be separated by centrifugation out of metal in the same way as butter is separated out of cream. This is true only to a very slight extent. If the metal could be kept fluid very long, say, several minutes, segregation of the lighter particles would probably take place. Actually, however, the viscosity of molten metal is entirely too high and it chills too quickly, even in hot moulds, to produce reliable separation of slag and dirt, although some takes place. In water-cooled moulds the chilling of the metal is practically instantaneous, and there is no segregation at all. It is, therefore, particularly important to have clean metal, whether it be cast iron or steel, brass or bronze.

Another element which has to be closely watched is that the metal should be at the right temperature. Excessively cold metal will not form good pipe, while excessively hot metal is apt to show up in the casting as blistery or frothy.

The next requirement, without which success is impossible, is the proper design of the machine itself and the proper layout of the work. In principle a centrifugal casting machine is extremely simple. It is nothing but a mould rotated at a rapid rate and a spout to supply the metal. Where warm moulds are used all that is necessary is to make the whole structure extremely strong so as to prevent vibrations and distortion under the great centrifugal stresses used. While this sounds very simple those who have designed such machinery will agree that it is by no means quite so easy to accomplish in practice as it looks on paper. It should also be clearly realised where a clay lining is used that outlets should be provided for the gases generated in the core under the action of the molten metal. The clay lining, no matter how solidly baked, will contain a certain amount of air. When the molten metal strikes it the air expands from the heat, and unless another outlet is provided for it makes its way through the molten metal, causing in it peculiar pin holes having the shape of tiny inverted cones. Another trouble with clay-lined moulds is their ability to accumulate moisture, which also expands from the heat of the molten metal and forms steam, and this results in another series of pin holes somewhat but not quite similar to those produced by the expanding air. The best way to obviate the formation of these pin holes is by keeping the lining hot enough to prevent any moisture content, which means not less than 315 deg. Cent., and providing for venting of the clay lining, which can be done by drilling numerous small holes in the shell containing the clay lining. Just a few holes will not do, and at least 5 per cent. of the surface of the shell should be drilled out in small holes.

Non-ferrous Castings.

Where bronze or brass are cast centrifugally it is well to bear in mind two facts. The first is that these metals contract very powerfully on cooling, and, therefore, draw away rapidly from the mould, and the second that below their point of solidification they pass through a range of temperatures where the metal is quite brittle. If one bears in mind these two facts, it will easily be seen what may happen to a casting, especially of fairly large diameter and heavy wall. As it cools it draws away from the mould, and, therefore, is not supported against centrifugal forces by leaning against the mould. Centrifugal force produces in the cast cylinder a stress of the same character as hydrostatic pressure, tending to rip the casting apart longitudinally, and this tendency is facilitated by the brittleness of the metal. Those who have made brass or bronze castings know how often they come out split lengthwise. The proper way to obviate this is by watching the casting carefully and stopping the spinning as early as possible, the idea being to stop it just as the metal has solidified sufficiently to maintain its cylindrical shape.

In casting aluminium the same situation exists, with the exception that aluminium is not quite as brittle. On the other hand, moulds for centrifugally cast aluminium have to be rotated at a higher speed, because of the lower specific gravity of the metal, which means that they have to be built far more substantially than brass or bronze casting moulds.

The Moulds.

Cast iron may be used for warm moulds, but it should not be used under any conditions either for water-cooled or for hot moulds, and even for warm moulds its use is not recommended unless the moulds are very short, not in excess of 12 in. or very thick. A cast-iron casting is at best a somewhat uncertain proposition, and there are apt to be planes of weakness. In centrifugal casting very high stresses are induced in the mould mechanically, and especially thermally, and the combination of the two makes the use of cast-iron moulds a dangerous and uncertain proposition.

In warm moulds steel, especially steel pipe, may be used with fair safety, and its life will be fairly long where the clay-lined mould is used. Where the metal comes in direct contact with the mould in warm or water-cooled moulds there is no objection to the use of ordinary steel from the point of view of safety, but there is a danger that the life of the mould will be very short. An excellent material for use in moulds is of the following composition:—Carbon, 0.5 per cent.; chromium, 26 to 28 per cent.; silicon, 0.4 to 0.6 per cent.; and manganese, 0.6 per cent. This is known as the Becket metal, and has been developed in the laboratories of the Electrometallurgical Corporation. If the mould, after casting, is to be subjected to machining, it is important to keep the carbon below 0.5 per cent. Where conditions are such that no machining is expected, or only a little of it, the carbon content may be increased, the higher the carbon content the cheaper per pound the casting, but the more difficult the machining The mechanical strength of the material is not affected materially with the increase of carbon up to 2 per cent., and the price is lowered considerably by this. For hot moulds the Becket metal would appear to be most suitable.

Pouring Temperature of the Metal.

The rate of pouring of the metal is an important consideration except where movable spouts or movable moulds are used, in which case the size of the nozzle governs the rate of pouring automatically. Excessively fast pouring is decidedly harmful, and usually the best results are obtained with the slowest pouring consistent with good delivery from the ladle (this is particularly important in large castings where the bottom-pouring ladle is used) and good distribution of metal in the mould. It is also very important, as has been stated above, to keep the metal at the right temperature, the temperature of the metal having a good deal to do with the rate of pouring in that a hotter metal can be poured slower than comparatively cold metal.

Pouring Spouts.

Where stationary spouts are used it is a good plan to have the spout hot, and it is very important to have it clean. In the author's practice, dealing with hot-mould pouring, a short spout is used projecting into the mould for a distance of about 6 in. The following procedure has been adopted, which has given good results:—The spout is shaped something like a corn-cob pipe, the tobacco bowl corresponding to the end receiving the metal from the ladle, and the stem the delivery end. A two-part wooden box is made, and the spout embedded into it, filling the rest of the space with fireclay so that only a few inches of the spout project. At the bottom of the box are placed, projecting through the wood, two strips of steel $\frac{1}{8}$ in. by 2 in. by the length of the box. The whole arrangement is then put into an oven and baked hard, the wooden frame being, of course, burned away in the process.

The gas or oil torch is then set into the large end of the spout and kept there for the time while the spout was not in use. On the platform in front of the mould are bolted on two strips of steel with slots corresponding to the strips of metal embedded in the spout block. By the time the metal is ready for pouring, the spout is white hot, and all there is to do is to push it along the slots until the delivery end projects a proper distance into the mould, remove the torch or the metal, pull it back into its initial place, and replace the torch again. It has been found that there are no skulls in the spout even when such metals as high-carbon chrome or high-speed tool steel are poured, and the spout is not affected by the vibrations communicated to it by the mould.

Foundations.

In all designs of centrifugal casting machines the greatest attention should be paid to making the foundations and all parts of the machinery ample from the points of view of strength and rigidity. The question of first cost should be given only the most moderate importance, and the best material should be used throughout, not only because the rupture of the machine may cause considerable damage to life and property, but also because it will prove cheaper in the end. The stresses induced in the operation of a centrifugal casting machine on the machine itself and its foundations are so great that only the best materials will stand up. The writer has seen a case where a small centrifugal casting machine was set up without even being bolted to the floor, but simply held down by weights. He would dislike to be around the place with the machine in operation.

The best practice is to put a concrete foundation, preferably of the monolithic type, with substantial floor bolts having a shearing strength not less than ten times the maximum centrifugal stress on the machine. The frame of the machine should under no conditions be made of cast iron, except the bottom plate, the side and upper members being of either steel castings or substantial rolled steel members.

Centrifugal casting may be made very profitable, and is so simple that it can be carried on with unskilled labour with only one skilled man, who is usually the teemer, to supervise, but under no conditions will it pay to use unskilled engineering labour in the design and installation of the machine.

There is an old saying current among moulders to the effect that a lie in sand will be shown up in the metal. The same applies with still greater force to centrifugal casting, which is a process peculiarly impossible to be worked either by slipshod methods or on a shoestring, *i.e.*, economising on the quality of materials and on factors of safety in the design of machinery.

THE FEDERATION OF BRITISH INDUSTRIES have already presented to the Government a first interim report dealing with some of the main principles connected with the question of Inter-Imperial Trade, and they have now presented to the Government their conclusions on certain additional aspects of this problem which are of importance. They hope at a later date to be in a position to place on record their views on further questions which are still under discussion.

XUM

China's Iron and Steel Industry.

MR. L. W. HOYT, in a recent report,* gives a comprehensive survey of China's iron and steel industry. At the outset, he points out that considerable publicity has been wrongly given to the wonderful resources supposed to be at the disposal of Japan in Manchuria and other parts of China through the enterprise of her iron and steel engineers. From a blast-furnace operation standpoint, Manchurian ore is too low in iron content (30 per cent.), and will have to be concentrated. This is practicable, but the additional cost may prove too excessive. Manchurian coke is high in ash (16 per cent). and moisture (10 per cent.), and none too good.

For purposes of discussion, it is convenient to separate China's iron plants into three distinct groups, namely:—(1) The Hankow district, (2) the Peking (Chihli) district, and (3) the Mukden. or Manchuria, district. At present there are 12 completed blast furnaces, varying in age from 1 year to 30 years. By this is meant the period which has elapsed since they were "blown in" for the first time. Their rated individual daily output ranges from 100 tons to 450 tons of pig. The total rated output is 2,610 tons.

If Chinese blast furnaces and Japanese blast furnaces in China lived up to their rated capacity, the respectable total of about 900,000 tons of pig-iron would be produced yearly. In August, 1922, however, only 500 tons of pig was being cast daily —a yearly rate of only 180,000 tons. This rate will not be exceeded, at least until 1924. This shrinkage in production is not due entirely to the present depression in business. Four furnaces, idle through lack of funds, have a total rated capacity of 220,000 tons per year. Two other furnaces, with a capacity of 73,000 tons yearly, are obsolete. Adding these tonnages together, we have about 300,000 tons (293,000 exact) of pig-making capacity out of business due to causes beyond the control of the management or the present economic depression. Deducting this total from the 900,000 tons of rated capacity for the whole of China and Manchuria, we find that 600,000 tons of iron should now be the annual output of the entire country. But on August 15, 1922, the yearly rate was roughly only 200,000 tons.

The Hankow District.

There are two companies owning blast furnaces in this district. The leading interest is the Han-Yeh-Ping Iron & Coal Company, Limited, by far the largest plant in China. This Company owns six blast furnaces, a rail mill, plate mill and bar mills. The other Company, the Yangtsze Engineering Company, owns one 100-ton blast furnace, besides its engineering works, or bridge shop. The furnace was shut down about January, 1922. The Han-Yeh-Ping Company is the only Company in China which has ever manufactured rolled-steel products.

Hanyang Iron and Steel Works.

These Works are located at the confluence of the Han and Yangtze Rivers, and are within a mile of Hankow proper, the terminus of the Peking-Hankow Railway, and about 700 miles from the sea. The area is too cramped (110 acres) for efficient operation. The only advantage the location possesses is good water transportation. The site chosen was very low and almost marshy. The ground water, always present, has been a constant annoyance at the open-hearth, where frequently trouble is caused by damp chambers. On the Yangtze River front, a modern ore bridge with two grabs of English design (Fraser and Chalmers), handles the Tayeh ore and limestone, which is delivered close to the wharf during the high-water season, but which must be unloaded from a point 130 ft. further out during low water. This fall in water level necessitated the building of cantilevers capable of sustaining large grabs working at times almost 150 ft. from the face of the wall. When the grabs are working on the extreme end, there is an upward pull of 120 tons on the four rear columns. The overturning movement is counteracted by a 500-ton block of concrete. The unloader consists of two transporters, 50 ft. between centres, each fitted with a travelling carriage from which is suspended a crane capable of revolving 360 deg., while operating a grab weighing 7 tons empty and 11 tons full. The total weight of each grab and its transport is 43 tons. Owing to the high lift (75 ft. at times), and to the 650-ft. carry to the bunkers and back, the rate of unloading is curtailed somewhat. While the bridge is rated at 100 tons an hour per grab, Chinese operators generally unload at the rate of about 70 tons for each grab. Even this rate works out much cheaper than coolie labour and ensures a steady handling of material under conditions of weather.

When operating to capacity, the Hanyang plant handles at its two wharfs about 3,000 tons of raw materials daily, all from the other side of the river. The ore and stone comes from Tayeh, 80 miles down stream, and the coke from Pinghsiang, 310 miles south by rail from Wuchang, the city opposite Hankow on the Yangtze. This means that all the coke must be rehandled at the river, a rather expensive proposition even with cheap labour.

Cost of Raw Material at Hanyang Works.

Figures given by the author under this heading relate to the second quarter of 1922, but he explains that costs have appreciated since then. Taking the American currency at the par rate of exchange, the following figures result:—Pinghsiang coke at stock house, £3 15s. per ton; Tayeh iron ore, 11s. 8d. per ton; Tayeh limestone, 9s. 6d. per ton; native iron scrap at stock house (limited), 8s. 4d. per ton. From this it is readily seen that cheap pig-iron is out of the question at Hanyang, even if furnace operation itself were perfect. Burden sheets of Hanyang blast furnaces show that it requires on an average 3,000 lbs. of coke, 900 lbs. of limestone, and 3,500 lbs. of iron ore to make one ton of pig-iron. Taking 100 per cent. as the cost of one ton of pig, the cost sheets show that the raw materials enter into this cost in the following proportion:—Coke, 55 per cent.; iron ore, 13½ per cent.; limestone and manganese ore, 4½ per cent.; total, 73 per cent.; power, interest, labour, overhead, etc., 27 per cent. With coke at £2 18s. per ton and a consumption of 1½ tons per ton of pig made, we get a coke cost of £3 17s. 6d. If the coke cost is 55 per cent. of the total cost of a ton of iron at the cast house, the cost of pig is therefore £6. Labour costs entering into this figure do not exceed 2 per cent.

Furnaces No. 1 and No. 2 (British) were erected about 30 years ago, and each produced 100 tons a day, but they were blown out in 1920. They are nearly obsolete now, and probably will never make pig-iron again. Four Cowper stoves and one gas-cleaner served each furnace. The blast was supplied by one horizontal compound Cockerill blower and three vertical two-cylinder Teeside blowers Excess furnace gases fired eleven Lancashire and three B. & W. boilers.

Furnaces No. 3 (blown in during 1910) and No. 4 (in 1913) were built by Germans. They are of 250-ton daily capacity and, from an operating standpoint, work fairly well. They are hand-filled, the buggies being hoisted by elevators to the charging floor. Blast pressure is about 6 lbs. per sq. in., and is supplied by three turbo blowers, one of which is used as a spare. Two of these blowers are by Parsons and the other by Richardsons, Westgarth & Company. They can deliver 30,000 cub. ft. per min. at a pressure of 9 lbs., but under local conditions 6 lbs. is sufficient. Lancashire and B. & W. boilers, fired by excess furnace gas, furnish the steam.

These furnaces are the only ones in blast in the entire Hankow district, but even they are being operated at a loss, all costs considered.

Unless assistance is arranged, it is difficult to understand how operation can be continued by the present management. The Tayeh mines are well situated, and the ore contains about 60 per cent. iron. With 40,000,000 tons in sight, these mines alone are very good security. The ore is

* "Far Eastern Review."

the best in China, and is the equal of most ores in America. The following are analyses of ore and of the coal from which coke is made:—Ore: Fe, 59.45 per cent.; Mn, 0.63 per cent.; S, 0.119 per cent.; P, 0.109 per cent.; Al_2O_3, 1.05 per cent.; Cu, 0.292 per cent.; SiO_2, 9.16 per cent. Coking coal: Fixed carbon, 54.118 per cent.; gaseous matter, 23.490 per cent.; combined water, 1.392 per cent.; ash, 21.000 per cent. It is evident that the coke will contain considerable ash. This is the case, the average ash content being about 18 per cent. Moisture in the coke is also very high, being about 10 per cent. or even more.

With coke containing 10 per cent. moisture and 18 per cent. ash, it is readily seen why, despite a good ore, it takes 3,000 lbs. of coke to make a ton of pig. An additional drawback to efficient blast-furnace practice at Hankow is the moisture in the air. Hankow is one of the wettest spots in the Far East from a humidity standpoint, especially during the summer months. This eats up considerable coke.

The pig-iron made at the Hanyang Works is a good product. No. 1 foundry iron has the following analysis:—Si, 2.75; Mn, 0.50; P, 0.150; S, 0.03 per cent. Basic pig used at the open-hearth furnaces runs about:—Si, 1.00; Mn, 1.25; P, 0.150; S, 0.03 per cent.

At present all the foundry iron produced is cast in sand pig beds in the cast house adjoining the furnaces, but the basic in iron moulds. Eight casts are made per day from each furnace. The pig is hand-broken by coolies and carried out of the cast house when cool to cars, which transport it to the loading wharf. When the open-hearth steel furnaces were operating, some of the molten pig was cast into hot-metal ladles, which in turn were emptied into the 150-ton mixer at the open hearth. The pig-iron production at Hanyang (furnaces Nos. 3 and 4) has been as follows:—In 1915, 136,531 tons; in 1916, 149,929 tons; in 1917, 149,664 tons; in 1918, 139,152 tons; in 1919, 166,096 tons; in 1920, 126,305 tons; in 1921, 126,496 tons; which figures show that, while the furnaces are rated at 250 tons, actual production was only about 200 tons. Time out for re-lining and "banking" reduced production. Due to good ore, fair coke, and lack of innovations in construction, these furnaces, from a metallurgical standpoint, operate better than most Chinese furnaces.

Open-Hearth Steelworks at Hanyang.

The steel-making plant at Hanyang (the only one in China) consists of seven 30-ton basic open-hearth furnaces and one 150-ton mixer. These furnaces were built about 15 years ago to furnish steel ingots for the blooming mill installed at the same time. Owing to the scarcity of cheap steel scrap in China, the furnaces are operated on about an 80 per cent. pig basis. Except in case of emergency, practically the only scrap used is that recovered from the pit and the rolling mills. Being so highly "pigged up," the furnaces operate much slower, averaging, when other things are all right, about two 30-ton heats per day. Figures during the last six years show the following ingot tonnage produced:—In 1916, 43,104 tons; in 1917, 60,933 tons; in 1918, 25,146 tons; in 1919 (Japan took pig), 4,850 tons; in 1920, 50,912 tons; in 1921, 46,800 tons. Finished steel tonnage (mostly rails): In 1916 (cold stock rolled), 45,043 tons; in 1917, 42,651 tons; in 1918 (cold heats charged), 26,994 tons; in 1919 (pig sent to Japan), 3,684 tons; in 1920, 38,260 tons; in 1921, 35,100 tons.

Under prevailing operating conditions, the blast furnaces provide more pig than the open-hearth needs (150,000 tons), the capacity of which is larger than the mill capacity, and finally the mills produce more steel products than can be sold profitably under prevailing prices. Of course, pig-iron can generally be sold to Japan at a price, but it seems poor foresight to have continued operating seven 30-ton open-hearths spasmodically when two 75-ton furnaces could easily supply enough steel, allowing time for periodic re-lining too. This would save tons of gas coal and much labour per month, for instead of 18 gas producers, 6 modern producers would be sufficient.

The furnace floor of the open-hearth is served by two 35-ton electric cranes, and the charging boxes are handled by a Wellman charging machine. On the pit side of the building are two 50-ton ladle cranes, a pouring platform, and a hydraulic stripper. The steel ingots are cast in moulds set on turtleback cars, and, when stripped, are brought to the blooming-mill soaking pits by locomotives. A charging crane (Wellman machine) places them in the heating pits.

Although the 40-in. blooming mill and the 28-in. rail mill (used also as a structural mill) were only installed about 15 years ago, no one at the time seemed to have been cognisant of the continuous mill, which in 1907 was quite common in the United States. The Hanyang blooming mill can "knock down" a four-rail ingot into a bloom in fairly good time, but when the hydraulic shears have cut the bloom into 2 two-railers, the delay is very noticeable. The fact that the bloom must be cut in two is a serious handicap. Costs start to rise at the 28-in. mill because both the first and second roughing as well as the finishing rolls are in line, *i.e.*, in one train, and naturally the second two-railers cannot enter the first roughing rolls until after the first two-railer enters the finishing pass. It would be slow enough even if the four-rail bloom could be reeled direct from the blooming mill. Owing to lack of room, this is impossible, and all blooms are therefore cut and reheated before reaching the first roughing rolls. When working to capacity under these conditions, it is not surprising that only 120 tons of rails are rolled per day. The 28-in. mill (rail-mill train) is driven by a 6,500-h.p. Davy engine. Another engine (Daniel Adamson), of 12,500 h.p., can be "hooked up" to the other end of the roll train when desired. The total weight of housings, couplings, pinions, rolls, etc., is fully as great (and the engine power too) as would be required in a continuous mill. The output is, however, but 25 per cent. of that possible in a continuous mill. Structural shapes up to 12-in. by 6-in. beams are also rolled on this 28-in. mill.

In line with the blooming mill is the plate-mill roll train driven by a 2,500-h.p. Davy engine. A roughing and a finishing set (two-high) constitute this unit. A motor-driven plate-straightener set is in line with the finishing mill. This plate mill turns out plates from 2 ft. to 7 ft. wide and from 1 in. to ¼ in. thick.

A three-high 16-in. bar mill is used for rolling fishplate, bars, etc. A light rail mill rolls from time to time rails under 30 lbs. per yard. Nineteen coal-fired Lancashire boilers supply steam to the big mills, and a further eight boilers furnish power for the lighter mills.

The products turned out by these mills are up to British Standard Specifications. The rails conform to a very severe drop test, which is practically the same as the British Standard rail tests. The author has little criticism to make of the sections rolled, which conform pretty well to template. The chemical specifications are liberal, especially as regards sulphur and phosphorus. A spread of 20 points in carbon is also very liberal. Pieces of rails must, on analysis, comply with the following:—Carbon must not be less than 0.40 per cent. nor more than 0.60 per cent.; phosphorus, not more than 0.075 per cent.; sulphur, not more than 0.06 per cent.; silicon, not more than 1.00 per cent.; manganese, not more than 0.90 per cent. Should any piece of rail analysed not comply with these conditions, the cast from which it is taken is rejected and fresh samples taken from the remainder.

In concluding his survey of the Hanyang Works, the author remarks that, from a 1922 American standpoint, not a single one of the units (with the possible exception of No. 3 and No. 4 blast furnaces) could be kept in operation. From the standpoint of efficient consumption of blast-furnace output, the steelworks are a failure, and likewise the mills. From a tonnage standpoint alone these mills are an expensive luxury, and the situation cannot be made better unless the open-hearths and mills are scrapped and new mills (continuous rail and universal plate) are erected at Tayeh, where there is plenty of room and good ground for foundations. The Chinese management began to realise this last year and shut down all the mills and open-hearth furnaces last November. It is almost certain that the

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present mills are considered obsolete by the management, and there is little chance that they will ever make steel in any quantity again.

Figures on the cost of steel rails f.o.b. the plant are not officially available, but it is known through a very definite source that just before closing down the rail mill, Hanyang rails were costing not less than Taels 95 per ton, or, at the present rate of exchange, about $71 gold (£14 16s.). Imported rails have been selling recently c.i.f. Shanghai for $50 gold (about £10) per ton, so the situation is very bad for the Hanyang product.

The primary reason why pig and steel costs are so high at the plant is the excessively high cost of coke, due to costly transportation by rail and to rising coal-mining charges. The coke is also none too good in itself, being friable and high in ash and moisture. If the cost, however, could be substantially reduced on coke, the physical drawbacks could be withstood and a reasonably-priced iron made.

(To be continued.)

Desulphurising Power of Blast-Furnace Slags.*

By RICHARD S. MCCAFFERY and JOSEPH F. OESTERLE (Madison, Wis.).

This investigation was undertaken to determine the quality of different blast-furnace slags as desulphurising agents, and the possibility of using in the blast furnace, materials of higher sulphur content than is now usual. The solution of this problem would render possible the use of higher-sulphur iron ores for pig-iron, the use of cokes containing more sulphur than now employed, and the economic manufacture of iron and steels of lower sulphur content.

It is generally assumed that the sulphur that reaches the lower part of the blast furnace is removed from the iron by combining with lime to form calcium sulphide. Most of the sulphur introduced with the charge is in combination with iron or manganese, or perhaps in the coke, as a carbon compound. Iron and manganese sulphides are more soluble in iron than is calcium sulphide, but as the latter is more soluble in the slag, this fact tends to free the metal from sulphur. The reaction $FeS+CaO+CO=Fe+CaS+CO_2$ requires a high temperature and strongly reducing conditions in the presence of lime.

The investigation of sulphur solubility was begun by determining the solubility of calcium sulphide in each of the three minerals, anorthite, calcium bisilicate, and gehlenite, which constitute the largest part of the ordinary blast-furnace slags. Mixtures of chemically pure lime, alumina, and silica were made in the proportions present in anorthite, and calcium sulphide was added to these in definitely varying amounts. The slags resulting from these melts were carefully analysed, and the results reported are on the basis of these analyses. A series of cooling curves was determined for anorthite with these different percentages of calcium sulphide. This work amounts to the determination of the equilibrium of the binary systems: $CaS—CaO.Al_2O_3.2SiO_2$, $CaS—2CaO.Al_2O_3.SiO_2$, and $CaS—CaO.SiO_2$.

The system calcium sulphide-anorthite forms a eutectic with 6 per cent. calcium sulphide, melting at 1,440 deg. C., with a probable compound containing 11 per cent. calcium sulphide melting at 1,500 deg. C. In a similar way, the equilibrium of the system $CaS—CaO.SiO_2$ (calcium bisilicate) showed a eutectic of 2 per cent. calcium sulphide melting at 1,200 deg. C. For the system $CaS—2CaO.Al_2O_3SiO_2$ (gehlenite) the eutectic contains 4.5 per cent. calcium sulphide, and melts at 1,390 deg. C., and a probable compound containing 6 per cent. calcium sulphide, melts at 1,460 deg. C.

With the equilibrium of the systems being known and plotted, the solubilities of calcium sulphide are then indicated by the intersection of the horizontal temperature lines with the liquidus curve.

From these calcium sulphide solubilities, and the mineralogical composition of slag of any analysis having been determined, the solubility of calcium sulphide in slags within the range of composition generally employed for iron-furnace slags, and extending well beyond this, were calculated

Solubility of Calcium Sulphide at Various Temperatures, in Percentage of Total Melt.

Degrees C.	Bisilicate.	Anorthite.	Gehlenite.
1600 ..	40	42	44
1550 ..	31	33	35
1500 ..	22	24	27
1450 ..	13	16	18
1400 ..	4	17	10
1350 ..	4	17	10

at temperatures of 1,350 deg., 1,400 deg., 1,450 deg., 1,500 deg., 1,550 deg., and 1,600 deg. C. In the same way, the solubility of manganese sulphide was ascertained, first in the individual slag components and then in slags of stated composition and at these temperatures.

Summary of Results.

(1) The effect of alumina in blast-furnace slags is to increase the solubilities of the slags for calcium sulphide and to diminish their solubilities for manganese sulphide.

(2) The effect of high temperatures in increasing the solubilities of the slags for both calcium and manganese sulphides is very marked.

(3) The actual chemical composition of the slag, as affecting the solubilities of calcium and manganese sulphides, is of less importance than the temperature of the slag.

(4) The change in calcium- and manganese-sulphide solubilities is probably less influenced by the basicity of the slag chemically than it is by the indirect action of the more basic slag in increasing the hearth temperature.

(5) The region in which solution of calcium and manganese sulphides in the slag is most rapid is the hearth of the blast furnace.

* From a Paper to be read before the Canadian meeting (in August) of the American Institute of Mining and Metallurgical Engineers.

Synthetic Grey Iron for Castings.

Carburisation tests to determine the feasibility of making synthetic grey iron in an indirect-arc rocking-type electric furnace have been made at Detroit by engineers of the Bureau of Mines. The results were very gratifying, an excellent quality of grey cast iron being produced in every test. The carbon content of the metal was under control. With this type of furnace it was found best to mix some grey iron scrap with the steel scrap in order to get the melting started at a lower initial temperature, and thus avoid overheating the roof. Test bars 1½ in. in diameter were made and broken on 12-in centres. Deflections as high as 3.65 deg. and breaking strengths of 3,000 lbs. were obtained. On the evidence of these tests an inspector for one of the large automobile plants in Detroit placed a large order for castings, specifying electric furnace iron and agreeing to pay a premium therefor.—"Iron Age."

THE PNEULEC MACHINE COMPANY, LIMITED, who have recently completed their new works in Mafeking Road, Smethwick, have appointed as agents for South Wales the South Wales Supply Company, 15, Park Place, Cardiff, who will handle all Pneulec lines, which, in addition to moulding machines, now include a complete range of foundry requisites.

MEMBERS of the Joint Works Committee at Messrs. John Lysaght's Orb Works, Newport, visited Scunthorpe recently. They were met by the members of the Joint Works Committee of the Normanby Park Works, shown round the mines and works and entertained in the grounds of St. Vincent House, the residence of Mr. J. W. Brooke. Presiding at the luncheon on Saturday, Mr. J. W. Brooke, the general manager of the Normanby Park Works, said it might be interesting to them to know that prior to 1920, their output at the Normanby Park works was about 2,600 tons a week, and they now averaged about 3,500 tons a week. It was the first firm in the district to blow 5 blast furnaces, and they were now making up to 4,500 tons of pig-iron a week.

Organisation, Trade Depression, and Personal Progress.

By W. J. Hiscox.

For some years past leaders of thought have been concentrating upon "efficiency," and emphasising the fact that there is "plenty of room at the top." They have pointed out that industrial leaders and directors are wanted, and that ambition is not only a worthy object, but a most necessary characteristic.

The call has been responded to with fervour, and "determination to succeed" has brought many to the top. They set themselves to do better than their fellows, and insisted upon lifting themselves above the rank and file; and whilst the latter browsed contentedly, the ambitious ones fought and strove, in the endeavour to fit themselves for something higher.

It is not altogether a case of the "survival of the fittest," for force of circumstances plays an equally important part, and the man who fails after a period of success must not of necessity be deemed incompetent. He may, it is true, have failed "to stay the course," and must give place to one who is better equipped; but, on the other hand, the actions of others may have constituted the adverse factor which placed above him one whose qualifications were by no means higher.

Two factors have of late years had a remarkable influence upon the progress of the ambitious man, the first of these being "organisation" and the second "trade depression." It is strange perhaps to find factors so diverse acting apparently in concert, and yet it will be found that these have forged as strong a chain of circumstances as completely to withstand the onslaught of competency and the determination to succeed.

Lest this should be questioned by those whose good fortune it is to remain on top, let us consider what can (and does) happen when organisation decrees that a certain department must lose its identity, or when trade depression necessitates the closing down of a portion of the factory. The head of the department is, in either case, the principal sufferer, for not only has he lost that for which he fought, but his prospects of finding other similar work are remote.

In dealing first with what may be termed the "organisation" factor, it cannot be contended that the submerging of his department can be prevented by its head. It may be thought by some that incompetency or inefficiency is the cause, but often this does not enter in the scheme of things, whilst, on the other hand, the high degree of efficiency attained by the department may bring about the downfall of the man who was primarily responsible for that efficiency. That this is not an idle statement may be proved by the following.

A promising member of the staff was instructed to establish a certain department, and for some time he enjoyed the title of "Head of —— department." He engaged and trained his own staff, and in a short time the new department was giving entire satisfaction, the "Head" receiving the congratulations of the management and a fairly substantial increase on his salary, by way of reward.

It is evident from this that there was no question of incompetency on the part of the "Head," or of inefficiency in regard to the department. On the contrary, there is every evidence that the ambitious man had "made good," and yet, after holding the position for twelve months, he was deprived of it in the following manner.

The success of the department suggested to the management that its scope could be considerably extended, and a reorganisation scheme followed, which brought to this department many of the duties hitherto handled in other departments. This lightened considerably the responsibilities of a prominent official, who was thereupon offered the controlling position in the enlarged department, the erstwhile "Head" being designed for the post of "chief assistant."

From a financial standpoint the deposed "Head" was a gainer, but he declined every inducement to accept the new position. It was pointed out to him that the new "Head" was a senior official, and that the deposition was no reflection upon his capabilities, whilst he would undoubtedly secure the controlling position in the event of the new "Head" resigning.

He objected on the score that his status had been reduced—that instead of dictating a policy he would have to carry into effect the policy of another man. There was the possibility of disagreement arising between the new "Head" and himself, in which case he would probably be forced to resign. In the latter event, how would he describe himself when applying for employment elsewhere? As late "Head" of —— department, but now chief assistant? If so, is it likely that the prospective employer would appreciate the motives of the management in the matter of his deposition, or would he assume that he had been reduced owing to inability to control? The questions were never satisfactorily answered, and the man left the company's service, whilst still enjoying the title of "Head." Was he right?

Another case is where a certain firm had two factories adjoining, and controlling each was a man known as the "works manager." At the time each factory had its own policy, and each engaged upon a separate line of manufacture, but it occurred to the directors that a common policy would be more economical, for work could be handled upon machines in either factory, irrespective of the line of manufacture for which it was required.

In these circumstances, there could not be two controlling "heads," and so the senior of the two officials was given the title of "works manager," whilst the other was termed "chief foreman." The former was the controlling head of the two factories, but he confined his attentions chiefly to his own factory, and did not interfere with the control of the "chief foreman" in the adjoining factory. Yet the latter was dissatisfied, because his status was reduced. On the surface it would seem that he was incompetent, but as a matter of fact it was force of circumstances that brought about his apparent failure to hold that which he had won.

In each of the two instances quoted, the man, although not suffering from any financial disability, indeed suffered a loss of status, and this has a retarding effect upon his progress, which is decidedly unfair. Some may say that, so long as the salary remains unimpaired, the man will regard with equanimity any relief in the matter of responsibility, and that he does not suffer on account of the change; but practical experience proves otherwise. To the man, alike ambitious and conscientious, such a reduction smears the end of everything upon which he has set his heart, and rather than submit he sacrifices a "comfortable and assured living" in the endeavour to retrieve his status.

And if it is hard for the man in these circumstances, what must it be for him when (again through no fault of his own) his status and his salary are both reduced? Here, perhaps, "trade depression" is the predominant factor; for although organisation calls for certain changes, it is not often that these changes entail a reduction in salary. Trade depression, however, plays havoc with the factory, and if it is continued for any length of time measures have to be taken to ensure economy in working, and many things which hitherto have been regarded as indispensable are now looked upon as being superfluous.

Let us take, for the purposes of illustration, the firm which, in the days of prosperity, found plenty of work for, say, a time-keeping department and a wages department, each controlled by a man whose efficiency was unquestioned. As the depression increases in intensity, it is deemed necessary to reduce expenditure by amalgamating these two departments under one head, the new department

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to be known as the "time-keeping and wages department."

The question of control may be decided by seniority, or by the relative importance of the work to be done by the sections comprising the department, or, in other words, under the new scheme the "axe" is applied with the greater vigour to one department. Thus, for example, whilst the reductions in the wages department are largely automatic, due to decreasing business, the reductions in the time-keeping department are extended by the cancelling of various parts of the organisation. If this be the case, it is quite probable that the head of the wages department would assume the position of chief of the combined departments, under whom his erstwhile colleague would be expected to serve as a subordinate.

This is a most distressing position for the latter, for not only is he expected to obey the commands of one who hitherto has been regarded as an equal, but he must suffer a monetary loss besides. It is not to be expected that the subordinate will receive a salary equal to that of his chief, and yet, through no fault of his own, he must submit to this two-fold reduction, or seek a better position elsewhere.

In regard to the latter, he is not so favourably circumstanced as is the man driven out by "organisation," for trade depression is widespread, and is not confined to any one factory. He must therefore submit, or run the risk of unemployment, either contingency, working bitter feelings in the breast of the man who has succeeded for a period, and then lost all he has striven for.

Trade depression may have even more serious effects, for in some instances the entire factory has been closed down, whilst in others a partial closing has thrown many out of work. In regard to the latter, the head of the department may have the melancholy satisfaction of seeing his subordinates provided for, whilst he is forced to quit. In many cases the lower-grade men can be provided for, but the management would not insult the dignity of a deposed "head" by offering him a subordinate appointment in another department!

When out of employment, the man naturally seeks a position similar to the one he has been forced to vacate, and he does not wish for his financial position to be impaired if it can be avoided. If trade depression be the cause of his fall, however, his chances of meeting with success are remote, for the positions vacant are secured by those whose salary demands are more modest. So once again his subordinates have the better opportunity, for whilst the salary they ask is comparatively low, their qualifications are sufficient to cope with the responsibilities involved, and they get the preference over their old chief, whose salary demand is much higher.

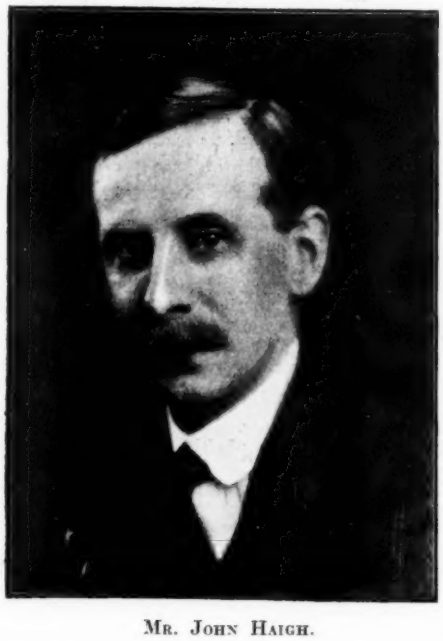
If, in course of time, he is compelled to moderate his demands, his previous position becomes a handicap, for his application is regarded with suspicion when the "salary asked" is compared with the last position occupied. If the advertised post covers "head" position, the smallness of the salary asked suggests to the prospective employer that the man was "incompetent," whilst for a subordinate position the employer rarely engages the man who has been "head of the department," even though the salary asked be low enough for the purpose.

There are, no doubt, many reasons why the man should be exhorted to strive for position, but he must also know that "the higher the eminence the greater the fall." Full of confidence, however, he does not contemplate a fall, and he considers that, by concentrating upon efficiency, his future is assured. This is true if everything depended upon his own effort, but, unfortunately, circumstances are oft-times stronger than the most fixed determination. It may be said that combined efficiency will triumph over all, but however efficient the man in the factory may be, he cannot ensure efficiency in, say, the distributive side of the organisation. There are too many factors over which he has not control to enable him to say, "I cannot be beaten."

There are hundreds of men walking the streets to-day in search of employment who are far more efficient than many who are in constant employment, and it cannot be suggested that, because they have failed to hold their jobs, they are incompetent. The old saying that there is "plenty of room at the top" is not so true as many would have us believe, and another thing which must be taken into consideration is that "those at the top" often get shifted first. When organisation holds sway, one may rise, but undoubtedly another falls, whilst trade depression, slaughtering the rank and file, does not disdain to take its toll of officers also. And, as in real warfare, it is not the incompetents who go first, but often those who are real directors, whose efficiency is beyond question, and whose only fault is that they are victims of circumstances.

"Moulders" of the Industry.—No. 11.

Mr. Haigh, who recently vacated the chair of the Lancashire Branch of the Institute of British Foundrymen, was born in 1874. He received both his ordinary and technical education in Oldham, the latter at the Municipal Technical School. He served his time with Messrs. John Hall & Sons, Limited, engineers and ironfounders, of Oldham. At the age of 26 he was appointed foundry fore-



Mr. John Haigh.

man with a Yorkshire concern, but after a few years returned, as foundry manager, to Messrs. Hall, who were at that time rapidly extending. In 1915 he was appointed foundry manager to Messrs. E. Green & Sons, Limited, of Wakefield. He is also a director of Messrs. J. W. Harrison, Limited, general ironfounders, of Wakefield. Apart from having passed through the Lancashire Branch chair in 1922-23, he is also a member of Council. Mr. Haigh also interests himself in the British Cast Iron Research Association, and serves both on its Council and Executive Committee. He has given several Papers, which in the main have related to the economical handling of materials, organisation and technical questions.

An important discovery of manganese ore has been made at Hekpoort, some distance from West Rand.

New Partnership.—Mr. F. A. R. Paton and Mr. F. C. Lawrence, consulting cost accountants, have recently opened an office under the name of Paton, Lawrence & Company, at 11, Victoria Buildings, Deansgate, Manchester.

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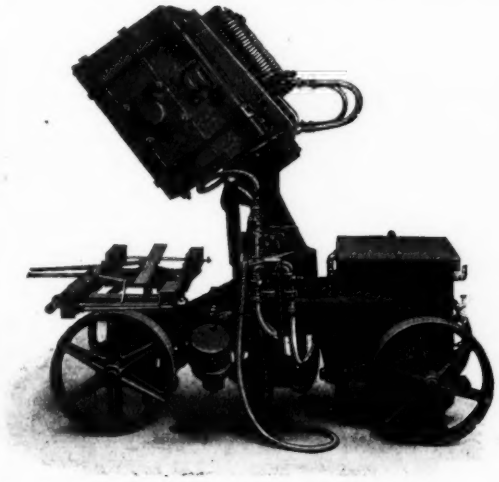

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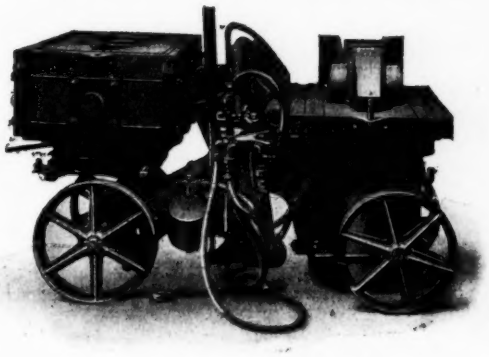

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IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—Conditions in the Cleveland iron market remain as unsatisfactory as previously reported, and with the advent of the holiday season there is little prospect of improvement before the end of the current quarter. Many substantial reasons for the present state of stagnation may be advanced—disturbed political conditions in Europe, high costs of producton, and a falling-off in foundrymen's consumption—but unquestionably, whatever the cause, the state of the Tees-side smelting industry has seldom, in recent years, undergone such a depressing experience as that within the past few months. The drift of prices continues downwards, but the process is so far too gradual to influence buying orders, consumers for the most part declining to recognise present quotations as by any means the lowest possible levels, and consequently confine purchases to hand-to-mouth tonnages. Some slight compensation to makers is, however, evidenced in a moderate increase in Tees-side exports, shipments of pig-iron from Middlesbrough during July up to and including the 24th inst. having amounted to 22,276 tons, as compared with 18,677 tons in the corresponding period of June. Market movements this week indicated makers as quoting 104s. for No. 3 G.M.B., as against 105s. a week ago, but the lower figure was again little more than a basis of negotiation, for any substantial offer at a reduction would be pretty promptly accepted. No. 4 foundry was offering at 100s., No. 4 forge at 97s. 6d., and No. 1, of which there is very little indeed available, at 115s. per ton.

On this week's quotations hematite is 4s. per ton cheaper than Cleveland foundry iron, and in actual business it is probably cheaper still. This should have the effect of stimulating the sale of hematite as compared with Cleveland, though at the moment it is difficult to discern any change in the situation. Demand is still very poor all round, and although there have been some further good sales to Germany this week, Continental inquiry is otherwise very stagnant. In this week's market East Coast mixed numbers were quoted at 100s. per ton, but it was possible to buy at less than this for any substantial parcels, and a transaction was reported to have been put through at as low as 99s. If that were so, the price is now no more than 9s. above the figure quoted at the beginning of the year. The No. 1 quality remains at a premium of 6d. per ton. In the West Cumberland hematite market prices are also weaker, Bessemer mixed members being down to £5 12s. 6d. to £5 15s. per ton delivered at Glasgow and Sheffield and for export, and special brands of iron, for which there is no large demand, are correspondingly lower in value.

MANCHESTER.—The local market for foundry iron continues idle, with actual business on a very restricted scale. The Derbyshire furnaces are still quoting 100s. in trucks for No. 3 pig-iron, and makers maintain that at this price there is no satisfactory profit, and that any further reduction is impossible until costs are lower—which means, of course, that the fall in pig-iron must depend upon the fall in coke. There are some sellers now below the 100s. limit, but at the same time there are rumours circulating about the blowing out of some of the Midland furnaces. The present trouble in the industry is just this: that the output of pig-iron is too large for the home market, and the export market has contracted to small dimensions.

THE MIDLANDS.—Business in all sections of the district pig-iron markets has been further restricted by many works closing down for the holidays, and the consequent cessation of deliveries for the time being. Inquiries for foundry qualities pig on export account have, however, been on a slightly improved scale, but the market can hardly be described as active, as will be realised from the fact that some of the Derbyshire makers have eased quotations a little. It is a very difficult market for smelters. Their coke is costing them much more than it should, in spite of the reduction to 26s., and demand is altogether inadequate. Earlier in the year, when sales were brisk, some of the furnaces which had been idle since the coal strikes might have been restarted if coke supplies had been available. Now the prospect of their entering the ranks of productive industry are as remote as ever. Current quotations:—Northamptonshire No. 3 foundry, 95s. to 100s.; Derbyshire No. 3 foundry, 97s. 6d. to 100s., all net f.o.t. furnaces.

SCOTLAND.—The great majority of the Clydeside works and shipyards inoperative on holiday account. The demand for pig-iron continues very moderate, with buyers and sellers alike indifferent to business. With demand still on a restricted scale, smelters consequently are stocking iron, and the price has fallen to 107s. 6d. for No. 3 foundry at the furnaces. Notwithstanding the unfavourable position, the number of furnaces in blast remains the same as last week, viz., 42. It is admitted, however, that the blast-furnace people are going very closely into the question of reducing the make, and it looks as if we may see more plants going out, in spite of the fact that there is only a little over 50 per cent. of the normal in operation. With the exception of the German market, export business has almost completely dried up, and even the numerous inquiries which were coming into the market recently have disappeared.

Finished Iron.

There has been no change for the better in the markets for finished materials, which remain idle and uneventful with demand restricted within the most moderate limits. In South Staffordshire manufacturers, with few exceptions, find it increasingly difficult to keep works even in partial employment, and the outlook is far from reassuring, as the volume of fresh inquiries continues extremely limited. Marked bar makers are still fairly well engaged on current contracts, mostly in connection with railway material, but, on the other hand, producers of crown quality iron are experiencing some difficulty in securing orders, competition in this branch being exceedingly keen, while demand for commoner bars is very poor, and Belgian importers are selling at cut prices.

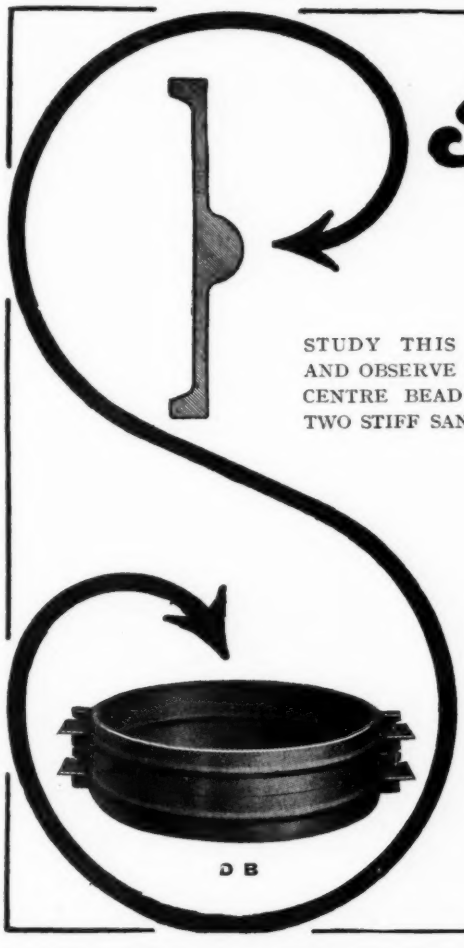
Scrap.

In common with the experience of all other metals, the market for scrap materials is stagnant and depressed, consumers only purchasing at present to meet the most urgent requirements, and then only in quantities just sufficient for immediate needs. In Lancashire the market for foundry pig-iron has still a long way to go before it reaches the level of last January, but cast scrap is already at, or in some cases rather below, that level, and in the ordinary course of events it cannot depreciate very much more. This ought to bring some confidence into the market, and no doubt when there is more work at the foundries there will be a good demand for this cheap material. Dealers have maintained their prices fairly well during the last fortnight, although it must be admitted that foundry pig-iron is weaker than it was a fortnight ago.

Metals.

Copper.—During the past week the tendency of the standard market has disclosed some irregular fluctuations in values, but on the whole may be regarded as fairly firm, quotations varying only within practical limits. Recently attempts have been made to put the market down on the strength of the political position, but it is obvious that this is purely professional manipulation by operators who do not fully understand European politics. The United States statistical position is regarded as better by those who fully understand it, and the American consumptive demand is well maintained. Current quotations:—*Cash*: Thursday, £65 5s.; Friday, £65 10s.; Monday, £65 12s. 6d.; Tuesday, £65 5s.; Wednesday, £64 17s. 6d. *Three Months*: Thursday, £66; Friday, £66 5s.; Monday, £66 7s. 6d.; Tuesday, £66; Wednesday, £65 12s. 6d.

Tin.—Following the improvement noted last week, movements in the standard tin market have taken a further upward turn, with the tendency of values distinctly firmer. The United Kingdom stocks have again fallen, being now 3,960 tons, against 4,054 tons in the previous week. The Straits shipments for the first half of July are estimated at 3,175 tons. For the full month 5,500 tons has been estimated, but at the moment there is very little indication of what the result of the visible supply statement will be. One of the outstanding features of the position is the resumption of American buying in anticipation of a good autumn canning season, and if this goes on the outlook must be regarded as favourable for the metal. There was a large business done in tin on the London market yesterday, over 1,100 tons changing hands, and final rates were not much under the best. In some quarters the metal is very well spoken of, but with the holidays ahead it is hardly the time for a bull movement to start. The recent sharp rise is probably in anticipation of further



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METAL MARKETS—*continued.*

American business coming along. Current quotations: *Cash*: Thursday, £183 12s. 6d.; Friday, £184 7s. 6d.; Monday, £184 17s. 6d.; Tuesday, £184 15s.; Wednesday, £183 15s. *Three Months*: Thursday, £184 12s. 6d.; Friday, £185 5s.; Monday, £185 17s. 6d.; Tuesday, £185 17s. 6d.; Wednesday, £184 15s.

Spelter.—From present indications the market for this metal may be reported as steadily improving, while the tendency of prices is towards higher levels. The market in America, state Rudolf Wolff & Company, has on the whole been inclined to weaken; production, however, seems likely to fall off in consequence of the low price and comparatively poor consuming demand. Statistics published there at the end of the month are as follows:—Production: May, 47,347 tons; June, 42,840 tons. Deliveries: May, 43,304 tons; June, 38,686 tons. Current quotations:—*Ordinary*: Thursday, £30 12s. 6d.; Friday, £31 2s. 6d.; Monday, £31 12s. 6d.; Tuesday, £31 15s.; Wednesday, £31 7s. 6d.

Lead.—The market for soft foreign pig continues firm, and the position on the whole is unchanged. Consumption remains fairly good, with demand principally for near delivery, confidence in the future being, so far, not sufficiently restored to induce buyers to make forward purchases. The dock strike in London has somewhat interfered with supplies, and backwardation, although now somewhat reduced, is still in evidence. Current quotations: *Soft foreign (prompt)*: Thursday, £24; Friday, £24 2s. 6d.; Monday, £24 7s. 6d.; Tuesday, £24 7s. 6d.; Wednesday, £24 7s. 6d.

Company News.

Vickers, Limited.—Interim dividends for half-year ended June 30, 2½ per cent. on preferred 5 per cent. stock (less tax), 2½ per cent. on 5 per cent. preference (less tax), 2½ per cent. on cumulative preference shares (free of tax).

Frome Engineering Company, Limited, Stoke Works, 24, Christchurch Street West, Frome.—Capital £2,500. Directors: A. A. Hobbs (managing director and manager) and Mrs. M. D. Hobbs.

Kepston, Limited, Water Lane, Berkhamsted, Herts.—Capital £12,000. Engineers, manufacturers of machinery, etc. Directors: E. Greene and A. Ritchie.

Planet Engineering Company, Limited, Eccles New Road, near Stott Lane, Pendleton, Lancs.—Capital £1,000 in £1 shares. Directors: T. Dootson and J. P. Lomas.

Rogers & Company (Shipbuilders), Limited, Cremyll Shipyard, Maker, Cornwall.—Capital £20,000 in 19,900 ordinary shares of £1 and 2,000 employés' shares of 1s. each. Permanent directors: F. J. Rogers, A. S. Rogers and N. Rogers.

T. F. & J. H. Braime, Limited, Union Foundry, Hunslet, Leeds.—Capital £120,000 in £1 shares (60,000 preference and 60,000 ordinary), to acquire the business of T. F. Braime & Company, Limited, now carried on at Ingham Street Works, Hunslet, Leeds, and to carry on the business of mechanical, locomotive and general engineers, iron, steel and malleable founders. Permanent directors: T. F. Braime and J. H. Braime.

Videx Company, Limited, 22, Huntsworth Mews, Upper Baker Street, London, N.W.1.—Capital £500 in 5s. shares. Engineers, pattern makers, iron and brass-founders. Secretary: F. J. Henocq.

Reduced Railway Charges.

Rate for Heavy Castings in Special Trucks.

It is announced that the following reduction in railway charges for conveyance of heavy castings by passenger train came into force on August 1:—

The rates for heavy castings and similar consignments conveyed in a special truck will be reduced from 10½d. to 9d. per ton per mile station to station, owner's risk. No less charge than as for one ton; minimum 30s.; 25 per cent. extra at company's risk.

Obituary.

MR. G. LEES, of Abel Lees & Sons, Limited, Wheatfield Iron Works, Bardsley, died recently, aged eighty-four.

MR. ROBERT LAMBERG, who has died at Edmonton, Essex, was well known in the steel trade. The deceased, who was in his 73rd year, was the representative of Messrs. Carl Setterwall & Company, of Stockholm. During the war period he rendered valuable service on the Sheffield committee for the disposal of iron held by the Ministry of Munitions.

Trade Talk.

THE 16-IN. MILL and the melting shop at the Earl of Dudley's Round Oak Works have been stopped.

CONSIDERABLE DAMAGE has been caused by an outbreak of fire at the Dowlais Works of Guest, Keen & Nettlefolds, Limited.

THE ADDRESS of the Institution of Automobile Engineers will be Watergate House, York Buildings, Adelphi, London, W.C.2, on August 1.

THE ABERDEEN UNIVERSITY COURT has decided to proceed in October or November to the election of a Professor of Engineering in the University.

THE UNDERFEED STOKER COMPANY, LIMITED, are removing on August 7 from Coventry House, South Place, London, E.C.2, to Aldwych House, Aldwych, London, W.C.2.

AN OUTBREAK OF FIRE has occurred in the basement of offices of the Metropolitan-Vickers Electrical Company, Limited, at Daimler House, Paradise Street, Birmingham. The damage was not heavy.

THE ASCERTAINMENT of the average selling price of Welsh bars for the past three months is £7 18s. 3¼d. per ton. This is an advance of 3¾ per cent. on the previous ascertainment.

LICENCES UNDER THE Non-Ferrous Metal Industry Act, 1918, have been granted to L. Jagger, Limited, Jackson Street, London Road, Manchester, and W. H. Owston, 209, Abbey House, Victoria Street, Westminster, London, S.W.1.

OF THE TOTAL number of vessels lost, condemned, etc., during the quarter ended December 31, 1922, 61 of 110,096 tons were constructed of steel, 12 of 9,751 tons of iron, and 58 of 23,763 tons were built of wood and composite.

SINCE NOVEMBER of last year the Charcoal Iron Company, Limited, of Backbarrow, near Ulverston, have made approximately 4,000 tons of charcoal and malleable pig-iron from Cumberland iron ores, and their furnace is still in blast.

THE BUSINESS of John Bennett & Sons, engineers, of Phœnix Ironworks, Bedford Street, St. Neots, has been acquired by Paine & Company, Limited, of St. Neots, and will in future be carried on under the style of John Bennett & Sons (Proprietors Paine & Company, Limited).

THE LAFARGE ALUMINIUM CEMENT COMPANY, LIMITED, with offices at Regent House, Kingsway, London, W.C.2, have been established to work under an agreement with the Société Anonyme des Chaux et Ciments de Lafarge et du Teil, for the sale in the U.K. of "Ciment Fondu."

ACCORDING TO THE report of the Disposal and Liquidation Commission the following sales have been made to March 31 last:—Plant and machinery, railway material and dock equipment, £23,272,818; ferrous metals, £18,874,519; non-ferrous metals, £50,469,128; chemicals and explosives, £28,018,605; road plant, £522,561; total sales in United Kingdom, £232,314,555.

MR. ALEXANDER K. STEVEN, vice-patron and chairman of the board of management, presided at the half-yearly general meeting of the Royal Metal Trades' Pension and Benevolent Society, held at 195, Upper Thames Street, London, E.C.4, on July 18, when 12 men and seven women were admitted to the pension without ballot. The following addition to Rule 10 of the constitution, recommended by the Auxiliary Committee, was adopted:—"That assistants in the trade below the age of 21 years, on payment of an annual subscription of 5s., be qualified as members of the Society, with voting powers and privileges equal to ordinary subscribers of half-guinea per annum. On attaining their majority the full subscription to be paid."

Personal.

DR. PERCY LONGMUIR has, we understand, resigned his position as director of the British Cast Iron Research Association.

SIR JAMES MCKECHNIE has resigned his position as managing director of the Barrow Naval Construction Works of Vickers, Limited. He will, however, retain his seat on the board of directors. Commander K. W. Craven has taken charge of the Barrow Works.

Wills.

BRAIN, H. G., of Stephens, Brain & Company, ironfounders, Bideford	£1,085.
SLOAN, W., of Carrick Foundry, Stanningley	£18,414.
ANDERSON, R., iron and steel merchant, of Liverpool	£6,723.
TRIER, F. H., of Trier Bros., Limited, mechanical engineers, 36, Victoria Street, S.W.	£19,077.